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THE embarkation of the body of Captain John Ericsson on board the *Baltimore*, for its final voyage to Sweden, on August 23, was made the occasion of considerable ceremony. The remains were accompanied from their temporary resting-place at the Old Marble Cemetery on Second Street, in New York, by a procession including a body of marines, a regiment of State militia, delegations from the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Marine Society of the Port of New York, several posts of the Grand Army, the Swedish Society, and other public bodies. From the Battery they were conveyed to the *Baltimore* by the steamtug *Nina*, and a number of other vessels were at anchor in the stream. A salute was fired from the old monitor *Nantucket*. The *Baltimore* at once started on her voyage, being accompanied down the Bay by a number of vessels.

As has been before remarked, such honors are very seldom paid to one who in his lifetime held no official position, but in this case they seem to be only a fitting recognition of the great services which Captain Ericsson rendered to this country, and, it may be said, to the world in general.

ONE of the most fatal railroad accidents reported for several years happened August 19, on the Old Colony Railroad, and, singularly enough, within a very short distance of the place where the great Wollaston accident took place 12 years ago. The train was an express, having seven cars, and was running at a high rate of speed when the engine left the track and turned over on its side down a low embankment. The tender and three cars also left the track, but remained on the road-bed and were not seriously damaged, but when the fourth car left the track the trucks were displaced and tore up the floor of the car, which then upset upon its side. The three rear cars remained upon the track.

With the exception of the fireman, who was caught under the engine and killed and two other trainmen who were slightly hurt, all the casualties occurred in this fourth car, and nearly every person in it was either killed or injured. There were some 50 persons in the car, and of these 11 were instantly killed, nine fatally hurt, and 18 seriously injured, some 10 or 12 more being slightly hurt. Had this car withstood the shock it seems as if the results would not have been serious, but its breaking up was the cause directly of all the injuries to passengers.

The accident will be carefully investigated by the Massachusetts Commission. The derailment was caused by a track-jack, which was left on the track by some sectionmen, in their haste to get out of the way of the approaching train.

THE latest report of the blast furnaces, as given by the *American Manufacturer*, shows a falling off in iron production. On August 1 there were in blast 321 furnaces, with a weekly capacity of 164,067 tons, as compared with 340 furnaces of 181,953 tons capacity on July 1. This shows a decrease in capacity of 16,886 tons, or 9¼ per cent.

The reduction is chiefly due to the stoppage of several large furnaces for repairs, and the usual summer slacking down. As compared with a year ago the statement shows an increase in the number of furnaces of 54, and in weekly capacity of 24,645 tons, or 18 per cent. The demand for pig iron continues good, and no increase in stocks unsold is reported.

THE furnishing of light and power from a central electric station on a very large scale is to be tried at Kansas City, if plans just formed are carried out. A large dam is to be built across the Kaw River, and the dynamos will be run by water power. It is expected that from this station electric lights can be supplied for Kansas City and all the neighboring towns, and that power can also be furnished to manufacturing establishments on a large scale.

THE latest plan for connecting the Long Island railroads directly with those of the main land has been brought forward by Mr. Erastus Wiman, who proposes to build a tunnel from Staten Island under New York Harbor near the Narrows to a point on the Long Island shore, thus practically extending the Baltimore & Ohio from its Staten Island freight terminus to a connection with the Long Island Railroad. Preliminary examinations, it is said, show that the building of such a tunnel is entirely practicable. Its total length will be about two miles. A company has been already incorporated.

THE Forestry Division of the Department of Agriculture has collected statistics of the number of ties used yearly in renewals on 112,455 miles of track in the United States, and also of the lumber used for bridges and other purposes on the same mileage. Calculating on this basis for the mileage not covered by these reports, it is estimated that the number of ties used yearly in the United States for renewals is 60,034,647, while the consumption of other lumber amounts to 681,407,511 ft. B. M.

Necessarily this is only an approximation, and it is believed to be under the truth, since an estimate of the whole number of ties in use shows that if only 60,000,000 were renewed yearly the average life of a tie would be about 8¾ years. A life of 6½ years and a yearly consumption of 80,000,000 is believed by the Forestry Division to be nearer the truth.

In several sections of the country decreasing supplies are reported, and it is necessary each year to transport ties greater distances. The various processes for preserving ties and timber seem, nevertheless, to be making very slow progress.

THE Fortification Bill, which has been pending for some time on account of the differences between the Senate and the House of Representatives, has been finally completed by a conference committee and has passed. The appropriation of $1,021,000 to complete the gun-factory at the Watervliet Arsenal was dropped from the bill, but it is said that there was an understanding that provision for this purpose will be made at the next session. The Senate amendment providing that 50 per cent. of the forgings now being made may be finished and assembled by private contract went into the bill, as also the amendment appropriating $50,000 for testing pneumatic gun-carriages and high explosives, and that authorizing the purchase under contract of 100 guns, 25 of them to be 8 in., 50 to be 10 in. and 25 to be 12 in. caliber. The appropriation for new tools at the Watervliet gun-shops was made $320,000.

Other appropriations for new work include $25,000 for gun and mortar batteries at Boston, $726,000 at New York and $260,000 at San Francisco; $500,000 for land for fortifications; $200,000 for finishing heavy guns; $400,000 for 12-in. rifled mortars and $225,000 for carriages for the same. Provision is also made for experiments with torpedoes and submarine mines, for heavy artillery practice and for steel armor-piercing projectiles. Upon the whole the bill is as liberal as the Ordnance Department could expect.

ANOTHER failure has been recorded in an attempt to use high explosives with cannon of ordinary pattern. In the present case the experiments were made with a type of steel shell invented by Dr. J. G. Justine, and the experiments were made under his charge at Perryville, N. Y. The gun used was a Blakeley rifle, and several trials has previously been made with it, using shells weighing about 330 lbs., carrying a charge of 18 lbs. of dynamite and projected by 35 lbs. of powder. In the test in question the charge of dynamite was somewhat less, and the gun exploded on the first shot, pieces of it being thrown in every direction. A large number of persons witnessed the experiment, but fortunately no one was hurt, owing to the precautions taken.

The gun was 9 in. bore, and the shells used were 44 in. in length, consisting of an outer shell of steel $\frac{7}{16}$ in. thick, enclosing an inner shell containing the dynamite, the space between the two shells being packed with a compound made by Dr. Justine. The exact cause of the explosion is not yet known, but it appears to have resulted from premature explosion of the charge of the shell.

THE Navy bill, as it finally passed Congress, is a compromise between the House and the Senate bills. It provides for six new ships, three of which are to be battleships of about 9,000 tons displacement, with a belt of 18-in. armor and carrying each four 13-in. guns, with a number of 8-in. and 6-in. guns; a fourth is to be a protected cruiser of large size—7,500 tons displacement—and high speed, with a heavy armament; the others are a torpedo cruiser of 750 tons and 23 knots speed, and a torpedo-boat similar to the *Cushing*. The authorized cost of the six ships, not including guns, is $15,225,000. Bids have already been asked for the three battle-ships.

Minor appropriations provide for the completion of the gun-making plant at the Washington Navy Yard; for the building of timber dry-docks at Port Royal and at some point on the Gulf of Mexico; for testing projectiles and armor-plates, and for testing a submarine gun.

THE RAILROAD YEAR.

ON another page will be found some figures from the summary given in *Poor's Manual* of the operations of the railroads of the United States during the past year. These figures are of interest as including the operations of practically all the railroads of the country, though the period covered varies, the fiscal year reported for differing with different companies.

For the last two years, however, the Interstate Commerce Commission has required reports from all the railroad companies subject to its authority. These reports cover a uniform year—that ending with June 30—and Mr. Adams, the Statistician of the Commission, has just completed a summary of the reports received for the year 1888–89, which include 153,385 miles of road, operated by 609 companies.

The figures show the magnitude of the railroad interest, for the stocks of the reporting companies amounted in all to $4,251,190,718, and the bonds to $4,267,527,859, a total nominal capital of $8,518,718,577.

The total earnings of the roads for the year were $964,816,129, an average of $6,290 per mile; the working expenses were $644,706,701, or 66.8 per cent. of the earnings; the net earnings were $320,109,428, an average of $2,087 per mile of road, and 3.8 per cent. on the nominal capital. After deducting $218,720,692 for fixed charges, there remained an apparent net profit of $101,388,736, or 2.4 per cent. on the total stock. The dividends actually paid amounted to $82,110,198, an average of 1.9 per cent. on the total stock; but a very large part of the stock received no dividend.

The year was generally a prosperous one for the railroads, and the total amount invested in improvements of road and additional rolling stock must have been very large.

ENGLISH AND AMERICAN LOCOMOTIVES AGAIN.

IN the JOURNAL for July we summed up the results of a triangular discussion of this subject by three of our cotemporaries. Up to the date of the publication of this summary our courageous American cotemporary, *Engineering News*, had not responded to the accepted challenge of the *Engineer*, to show wherein American locomotive boilers are superior to those made and used in England. In the number for July 18 the *Engineer* breaks the silence on this subject, which apparently had grown oppressive to its editors, and in an article endeavors to show wherein and wherefore English locomotive boilers are better than those made in America. In commenting on the part that "the oldest railroad paper in the world" has taken in the controversy, it says that "the last number contains a very amusing article summing up the whole controversy, so far as it has gone; but neither does it add

anything to the available store of facts." This observation may remind the reader of the man who went to hear Artemas Ward lecture and came away saying that the lecturer "was the blamedest fool he had ever listened to."

So far the controversy has not been very instructive, but it has been amusing. But where is Edward Bates Dorsey? If he would only enter the ring and "slash around" a little, the fun would doubtless grow fast and furious.

The *Engineer's* article of July 18 may be summed up by the statement that American locomotives do not evaporate more than from 5 to 7 lbs. of water per pound of coal, whereas English locomotives evaporate from 7 to 10 lbs.

This statement is very indefinite. Does our cotemporary mean that in ordinary practice our locomotives do not evaporate more than from 5 to 7 lbs. of water per pound of coal? If it means that it may be true, but it is an idle assertion, because nobody knows what they do, as there are comparatively few roads on which an account of fuel consumption is kept, and none of their officers ever thought of keeping a record of water consumption. If the above hypothesis of our cotemporary's assertion is its true meaning, it is nothing more than a wild guess or assumption, because nobody knows, or can know what they evaporate.

If, on the other hand, it means that in cases where a careful record has been kept of the fuel and water consumption, that our locomotives have not evaporated more than from 5 to 7 lbs. of water, the assertion has the serious fault of not being true, and the first real blow in this contest must be declared to be a "foul."

In evidence of this some experiments may be quoted which were made by the writer as far back as 1873 with an ordinary American four-coupled engine with four-wheeled truck, 17 × 24 in. cylinders and 5-ft. wheels. The maximum grades on which the experiments were made were 30 ft. per mile, the number of miles run 145 for each experiment, with the following results:

Weight of Cars Hauled.	Water Evaporated Per Pound of Coal.
Tons of 2,000 Pounds.	Pounds.
754.43	7.04
748.62	7.32
559.82	8.02

The train consisted of freight cars; the average running time was less than 20 miles per hour. The two heaviest trains were the maximum loads the engine could haul, or, rather, were greater than could be hauled, as in both trips it had to be helped up a short grade combined with a sharp curve. The fuel was Indiana coal, which is of poor quality if compared with that from Pennsylvania and Cumberland mines. The locomotive with which the experiments were made did not represent the best practice of that time—1873—and the best locomotive of to-day would undoubtedly give better results than any that could have been obtained at that date.

It will be noticed, from the figures which have been given, that the evaporation per pound of coal was considerably greater with the lightest load than it was in the two other cases, a fact of some importance which will be referred to again.

On the Grand Trunk Railway of Canada experiments have been made with an ordinary American engine with 17 × 24 in. cylinders, four-coupled 5-ft. wheels, and four-wheeled truck, with 38,864 lbs. of adhesive weight on the driving-wheels. The tests were made in July, and each test consisted of a run of 250 miles, with the following results:

Weight of Cars in Tons of 2,000 Pounds.	Water Evaporated Per Pound of Coal.
560	7.71
595	8.09
578	7.88
617	7.18
621	7.40
573	6.79
610	6.67
590	7.32
558	7.10

These experiments were made with an American type of engine, not of the most recent construction, and under the supervision of Englishmen, and without an extended smoke-box.

The above data give the results of such experiments only as are at hand at the present writing, and doubtless some of our readers could furnish many reports of other tests showing better results.

Our foreign cotemporary, in accounting for the hypothetically unsatisfactory performance of the American boiler, says further: "To get the full value out of coal there must be a brick arch in the fire-box, . . . if a brick arch is used the fire-box must be of copper."

Wrong again, esteemed cotemporary; you struck below the belt. It may surprise you to learn that on the Grand Trunk Railway which, with the exception of a few antiquated types of English engines, is equipped with American locomotives, most of them built in the United States, but under the management of your countrymen, there is not a single engine with a copper fire-box and not one without a brick arch. Briefly, it may be said that the use of the brick arch is very common in this country, but by no means universal. Your hypothesis and statement of fact are both wrong. Therefore the superiority of English locomotive boilers cannot be due to the causes assigned by you.

You have referred to the experiments made on the Paris, Lyons & Mediterranean Railroad. By studying these carefully you will see that the use of the brick arch reduced the quantity of coal which could be burned in the grate. Now the question arises, Will a locomotive do as much work with a brick arch in the fire-box as one will without? American locomotives are built to do work and as much of it as possible. On roads where coal is cheap the wages of the locomotive runner and fireman cost as much as the fuel does. If, therefore, they—the locomotives—pull, say, 10 per cent. more cars, the company is saving in wages as much money as it would if it hauled fewer cars and saved 10 per cent. of the coal burned. This does not take account of the conductors' and brakemen's wages, which are equal to or greater than those of the fireman and "driver," as you call the accomplished individuals who run the locomotives in your country. Preposterous as the statement may seem in many cases, it does not pay to save coal.

In making comparisons of the relative amount of water evaporated per pound of fuel by different boilers, the rate of combustion should be taken into account. Attention has been called to this in the experiments first quoted. Leaving out the odd figures, with an average load of 750 tons the evaporation averaged 7.16 lbs., whereas with only

560 tons it was over 8 lbs. We have also seen a report of an experiment made on a leading railroad by running an engine over the line without any load, which showed an evaporation of over 9 lbs. With a heavy load the same engine evaporated only a little over 6 lbs. It would throw some light on this subject to know how much coal you are burning in English locomotives. In some experiments with a passenger locomotive on the Grand Trunk Railway, it was found that the average coal consumption per square foot of grate per hour was as follows: 121.7, 106.3, 122.4, 135.1, 115.4, 127.5, 125.4, 119.3 lbs. Last month we reported some of the results of experiments on the Baltimore & Ohio mountain grade, showing that in one instance—not an unusual one either—193.7 lbs. of coal was burned per square foot per hour. Under such conditions the rate of evaporation would probably be low, but they are the conditions which control the working of locomotives on that part of the Baltimore & Ohio line. The boilers must burn that quantity of coal or the locomotives cannot take their trains up the grade 17 miles long and rising at the rate of 117 ft. per mile.

Now, most esteemed cotemporary, you are crying out for facts and light, will you not turn your mental searchlight on the railroad lines of your country and tell us what quantity of fuel you are burning in given periods? When you evaporate from 7 to 10 lbs. of water per pound of coal, how much coal are you burning per square foot per hour. In some cases we find it desirable to abandon the brick arch in order to increase the capacity of the boiler to burn coal. With a high rate of combustion our engines can take their trains, whereas without it they cannot, and it is found more satisfactory to burn a little more fuel than to have trains delayed.

The fact is, fair comparisons of locomotive performances are extremely difficult, unless they are made from records taken on the same line, with the same fuel and trains and under exactly the same conditions. It seems probable that American locomotives generally are worked harder than English locomotives are, and the differences in their performance are due more to that fact than to any inherent superiority in either.

Whether British coal is better than American, or English firemen are more skillful than their Yankee craftsmen, is not worth discussion in the absence of any means for testing the merits of either. It may, however, be said safely that there is a great deal of difference in the quality of both American fuel and American firemen. In the Western States there is a good deal of what may be called cussedness in both, but they do their work effectively, although there is often considerable sulphur combined with the carbon of the one, and the conversation of the other. Nevertheless, it would be entertaining if an opportunity were given to some of our firemen to handle a shovel in competition with a picked team of their English brethren.

To go back to the evaporation of English locomotive boilers, will the *Engineer* give us more exact statements of the circumstances under which they evaporate from 7 to 10 lbs. of water? After considerable amount of reading of railroad literature, and some observation on British roads, we never heard an intimation that any account is kept of the consumption of water on them in ordinary practice. If such an account is not kept, the data given by our cotemporary must have been obtained from some experimental tests which were carefully recorded. Give the circumstances and the particulars of those tests—the dimensions of engines, loads hauled, grades, speeds, distance run, were feed-water heaters used, did the injectors waste water, did the engines work dry steam, did the fuel consumption include that burned in firing up or raising steam? There are many circumstances which influence the results which should be known to be able to make fair comparisons. But, as remarked before, unless two locomotives are run on the same line, under exactly the same conditions, comparisons which will prove anything are difficult, if not impossible.

In its issue of August 2, *Engineering News* says that the weather has been too hot to discuss this subject very seriously; but it publishes a long article to show that we haul heavier train loads in this country than they do in Europe, which is doubtless true. As the *Engineer* remarks, at this rate we are not making much progress. Our foreign cotemporary's evidence breaks down on cross-examination, and our neighbor assumes a defensive attitude. It is not quite clear what the question at issue is, but it is safe, for the present, to hurrah for the American Eagle.

If it were possible to do so it would be very interesting and instructive if some railroad company, in a country foreign to the United States and to England, should give an order to some British locomotive building firm or company and another to an American establishment, instructing each to build a locomotive which, in their opinion, would be best adapted for freight or goods traffic where average running speed should not exceed 30 miles per hour. The engines alone, without the tenders, to weigh in working order 100,000 lbs., the weight per wheel not to exceed 12,500 lbs. When completed, the engine to be put to work beginning with light loads and gradually increasing them up to their maximum limit, a careful account being kept of the coal consumption, cost of repairs, and the general performance of the engine. Such an experiment would interest the whole railroad world and would be very instructive; but as there does not seem to be any immediate prospect that this will be done, we will suggest to our cotemporaries that they each design a locomotive to conform to these conditions, give full specifications of them, and publish the latter and engravings showing the designs and lay them before the public for criticism. Then will there be something definite to discuss, whereas the "American and English locomotives" are now only vague entities.

THE HARLEM BRIDGES.

THE Governor of New York withheld his approval from the bill passed by the Legislature at its recent session, which provided for the raising of the bridges over the Harlem River, thus leaving the much discussed question of the crossings of that river precisely where it was.

The question, being chiefly a local one, may require some explanation. The river traffic on the Harlem at present consists largely of barges and tug boats, the number of vessels with masts being comparatively small. There is no through navigation at present, for while the Harlem and the Spuyten Duyvil Creek together extend from the East River to the Hudson, a section is not navigable. Surveys have been made, however, and there have been some appropriations for deepening, widening and opening the channel so as to enable vessels of considerable size to pass through, and the advocates of that work anticipate that when it is completed the channel will be used largely

as a short cut by vessels coming down the Hudson and bound up Long Island Sound, and *vice versa*, while at the same time the river front will be a considerable addition to the dockage capacity of the city. Most of the bridges over the Harlem are now at a comparatively high level, enabling the ordinary barge traffic to pass underneath them, but two of the principal crossings—the bridge of the New York Central & Hudson River Railroad at Fourth Avenue and the Third Avenue highway bridge, belonging to the City—are low, about 15 ft. above high water, so that the draw-spans of both of these bridges have to be opened to permit the passage of the smallest vessels. The number of trains on the Central is very great, and there is an enormous traffic over the Third Avenue Bridge also, to which the frequent opening of the draws has grown to be an almost intolerable interruption, causing constant and very annoying delays, which would, of course, be very much increased should the ship channel through the river be opened. The bill, to which reference is made above, provided for the raising of these bridges to a height sufficient to permit all ordinary tugs and barges to pass beneath them, and in that case the draws would only require to be opened for masted vessels, which are at present comparatively few in number.

The problem of making any change in the crossing is complicated by the fact that the Central Railroad grade was lowered a number of years ago through the City in order to separate it entirely from the street grades, and that the Company is now expending a large amount of money on a similar work north of the river, which is nearly completed. To raise the bridge crossing 25 or 30 ft. as proposed would involve a heavy expense in changing the present grades, and would also interfere very seriously with the street crossings of the railroad, and the same trouble would be found in changing the grades on Third Avenue, which is one of the principal thoroughfares of the City. Hence it has been proposed in the interest of property owners to tunnel the Harlem and to do away entirely with the bridge crossings, but to this also there are very serious objections. The engineers of the Railroad Company claim that for a tunnel it would be necessary to go at least 60 ft. below the present grade, and the cost of such a lowering of the track, as can be easily seen, will be enormous, while very serious engineering difficulties would be involved. They also claim that this cost would be altogether out of proportion to the benefits to be derived from opening the course of the river, which they claim would accrue principally to the owners of property immediately adjoining its banks.

There is much reason in these arguments, for while a tunnel crossing presents no engineering difficulties which could not be overcome, there is no doubt that the cost would be very great. The traffic crossing the river is at present very much greater and of more importance to the City than that which is carried on it, and if the convenience of the traveling public alone is consulted, the latter should give way; but water traffic has by law certain rights which cannot be disregarded. At present, while the tunnel solution of the problem seems in many respects the most desirable, the raising of the bridges also seems to be the most convenient, practically the main objection to that being that it is only temporary in its nature. As the matter stands, however, it is not likely that anything will be done for another year.

This is only another case of the difficulties which inevitably arise over railroad entrances into large cities, the majority of which have been originally laid out at a time when no one did or could foresee the extent of the future growth of the railroad travel or of the City itself.

THE ISTHMUS CANALS.

THE Commission of French engineers, which was appointed to examine the Panama Canal and to see what could be done toward its completion, has made a report to the receivers who are now in charge of the Canal Company. Although the Commission is somewhat hopeful, it must be confessed that the facts given in its reports are anything but encouraging to investors. After carefully examining the ground the Commission recommends the completion of the canal in four sections, the first a summit level about 114 ft. above the level of the sea and about 12½ miles in length. This level would form a long and narrow lake, enclosed between two great dams barring respectively the valleys of the Chagres and the Rio Grande, and fed mainly by the waters of the former stream. Below this would be an intermediate level forming a second narrow lake, while at either end would be a stretch of canal at the sea level about 7½ miles in length at the Panama end and 15 miles at the Colon end of the canal. The communication between the different levels would be made by two double series of locks on the Atlantic end and by one double and two separate locks at the Pacific end. These locks as proposed would have a lift of from 30 to 36 ft. each, and would have an available length of about 600 ft. and a width of 66 ft. The engineers of the Commission believe that the long summit level or lake would provide sufficient room for the waters of the Chagres to expand without overflowing—a conclusion which seems scarcely warranted by the facts.

However its opinions may be regarded from an engineering point of view, financially they are not by any means encouraging. The estimated expense of completing the canal upon this plan is about $120,000,000, the principal items being $60,000,000 for excavation and $22,000,000 for locks. To this must be added the general expenses of the Company and interest upon the new capital to be raised, which will bring the total amount up to about $180,000,000, representing the amount which will have to be provided in addition to that already invested in the Company, while the time required will be about eight years. On the other hand, the estimates given of the return to be expected seem somewhat sanguine, for the annual cost of management and maintenance of the canal is put down at $2,000,000 only, while the return from traffic, it is estimated, will reach about $8,000,000 at the end of the fourth year after the opening and $12,000,000 at the end of the tenth year. Even with this estimate it is difficult to see how any reasonable return can be promised on the capital to be raised, while the prospect for the old securities of the company is very remote indeed.

It is also to be noted that in all this no account is taken of the probable construction of the Nicaragua Canal, all the estimates made looking to the Panama Canal as the only communication between the two oceans. It may also be said that a large allowance has been made for the value of the work already done and of the plant now on the Isthmus, and apparently very little allowance has been made for the rapid depreciation of both.

While the prospects of the Panama Canal are thus doubt-

ful, work on the Nicaragua Canal is advancing steadily, and there is every prospect that the work will be carried through. The company has now a considerable force on the line, and fair progress has been made on the preliminary works, so that in a short time everything will be in readiness for actual construction on the more difficult sections.

One very great advantage of this line is the much better climate and the consequent absence of much of the difficulty found in securing labor which has always been so serious a trouble at Panama. Of course labor must be imported to a considerable extent, but it is possible for the men to work and live, the chances of which at Panama were very small.

In Lieutenant Barroll's articles on Interoceanic Canals, published recently in the JOURNAL, are given some of the reasons for the failure of the Panama enterprise, and a careful reading of those articles will show causes quite sufficient to account for it.

NEW PUBLICATIONS.

UNITED STATES DEPARTMENT OF AGRICULTURE, FORESTRY DIVISION, BULLETIN NO. 4. REPORT ON THE SUBSTITUTION OF METAL FOR WOOD IN RAILROAD TIES: BY E. E. RUSSELL TRATMAN, C.E.; TOGETHER WITH A DISCUSSION ON PRACTICABLE ECONOMIES IN THE USE OF WOOD FOR RAILROAD PURPOSES: BY B. E. FERNOW, CHIEF OF THE FORESTRY DIVISION. Washington; Government Printing Office. Published by Authority of the Secretary of Agriculture.

This latest publication of the Forestry Division is chiefly made up of Mr. Tratman's final report on the Substitution of Metal for Wood in Railroad Ties, which gives at considerable length and with much detail the development of the use of metal ties and the present state of the question. Most of the reports are from foreign countries, since experience with metal ties in the United States has not, thus far, been extensive, although practical tests on a considerable scale have been begun. The report is accompanied by diagrams showing forms of iron and steel ties used in England, France and Switzerland; the Post tie used in Holland; the Berg & Mark tie in Germany; the Hohenegger tie in Austria, with several other forms; the pot and plate ties (cast iron) largely used in India; and finally the Hartford, the Toucey, the Standard and other forms of tie now being introduced in the United States.

Mr. Tratman's paper is prefaced by a report on the consumption of timber for railroad purposes, and by a short but interesting paper by Mr. B. E. Fernow, Chief of the Forestry Division, on Practicable Economy in the Use of Forest Supplies, treating of the best methods of prolonging the life of ties, including care in selection and handling; the use of tie-plates and similar devices, and various methods of chemically treating timber to prevent decay.

The subject is one that calls for attention, and this Bulletin should be read by railroad officers everywhere with care. The Forestry Division is doing excellent work in this direction.

MANUAL OF THE RAILROADS OF THE UNITED STATES FOR 1890: TWENTY-THIRD ANNUAL VOLUME. New York; H. V. & H. W. Poor, 70 Wall Street.

The yearly appearance of *Poor's Manual* has now come to be looked for as a regular event, and its reputation is so well established that there is really very little to be said of a new volume. As the only work of the kind, and an indispensable reference-book for investors and all others who are interested in railroads, it holds its place fully and will apparently continue to hold it.

That it has some defects is true, but most of them are really inherent in the manner in which it is necessarily prepared, as an unofficial publication. That on this basis it should be as complete as it is must be considered as due entirely to the care taken in its preparation, and the standing it has acquired by long-continued publication. One improvement which might be suggested is a more systematic arrangement of the companies, so that continual reference to the Index would not be necessary for those who have to use the *Manual* frequently. This is a minor matter, but is, perhaps, worthy of attention.

An improvement introduced this year for the first time is in the publication of separate maps of a number of the more important railroad systems. These are large enough to give a general idea of the position and relations of each system, and are given in addition to the general maps which have heretofore appeared.

The summary or introduction to the *Manual* gives some statistics of much interest. Some extracts from it will be found on another page.

MINERAL RESOURCES OF THE UNITED STATES FOR THE YEAR 1888: BY PROFESSOR DAVID T. DAY, CHIEF OF THE DIVISION OF MINING STATISTICS AND TECHNOLOGY, UNITED STATES GEOLOGICAL SURVEY. Washington; Government Printing Office.

The report on the mineral resources of the United States, of which the present is the sixth volume, long ago reached the rank of a standard authority upon the subject, the care with which it is prepared and the intelligence with which it is arranged and edited meriting high praise. Perhaps the statement made in the introduction to the volume itself will best express the method of arrangement as follows:

In this report the method of treatment in previous volumes has been continued. The report opens with a summary statement as to the condition of each mineral industry at the close of the period under review—the calendar year 1888. There is no attempt in this place to show the products of separate sections of the country. The division is entirely according to the minerals themselves. At the close of this summary is a table in which the values of the various products are added, so as to furnish an estimate of the relative importance of the mining industry as a whole. Following the summary, each important mineral industry is discussed in a separate chapter. The statistical tables given in former reports have been extended to include 1888, but otherwise the material in each chapter is intended to show the developments in 1888, and not in previous years. It is expected that the readers will consult the corresponding chapters of the six reports which constitute the series. For this purpose an index to the six volumes is in preparation.

In all publications of this kind some delay is inevitable, and the appearance of this volume is somewhat late, owing to the fact that it covers so many diverse topics. It has been, however, the practice of the Geological Survey to publish summaries of the more important proofs of the report as soon after the close of the period covered as possible, so that the statistics relating to the leading mineral products are accessible some time before the completion of the book.

NATIONAL CAR & LOCOMOTIVE BUILDER SUPPLEMENT. New York, July, 1890.

This *Supplement*, which is issued yearly by Mr. John N. Reynolds, from the office of the *National Car & Locomotive Builder*, contains a very useful directory, giving the names of all the makers of cars, locomotives, car wheels, axles and springs, and of all the rail mills in the United States. It has also a list of the officers of the street railroads of the United States, and of the railroad companies of South America—information not always to be found elsewhere.

As an advertising sheet, the *Supplement* might almost be taken for a directory of all the manufacturers of and dealers in rail-

road materials and supplies, for very few of them are absent from its pages.

BOOKS RECEIVED.

REPORT OF THE SECRETARY OF THE NAVY, 1889. PARTS I. AND II. Washington; Government Printing Office. These two volumes contain not only the Report of the Secretary, but also all the reports of the Bureaus of the Department, giving a complete history of a year of very active work on the enlargement of the Navy.

SECOND ANNUAL REPORT ON THE STATISTICS OF RAILROADS IN THE UNITED STATES, TO THE INTERSTATE COMMERCE COMMISSION, FOR THE YEAR ENDING JUNE 30, 1889. Washington; Government Printing Office. Some figures from this report will be found on another page.

REFERENCE BOOK OF THE NORFOLK & WESTERN RAILROAD COMPANY. Philadelphia and Roanoke, Va.; issued by the Company. This is a guide or hand-book intended to show the present condition of industrial progress in Southwestern Virginia, and to give some idea of the natural resources of that region, and especially of the sections reached by the Norfolk & Western Railroad and its branches. It is profusely illustrated.

REPORT OF THE FIFTH ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS, HELD AT PEORIA, ILL., JANUARY 29-31, 1890. Springfield, Ill.; published for the Society; S. A. Bullard, Secretary.

SPECIALTIES IN HARDWARE: ILLUSTRATED CATALOGUE NO. 7. New York; issued by Tower & Lyon.

CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE: BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION, NO. XVIII, JULY, 1890. Ithaca, N. Y.; published by the University.

AUTOMATIC QUICK ACTION AIR BRAKE SYSTEM. TEMPORARY CATALOGUE OF THE BOYDEN BRAKE COMPANY: ILLUSTRATED. THIRD EDITION, AUGUST, 1890. Baltimore, Md.; issued by the Company.

ABOUT BOOKS AND PERIODICALS.

IN the SCHOOL OF MINES QUARTERLY for July, W. H. Weed writes on Geysers; Lieutenant John W. Ruckman on the Wind Problem in Gunnery: T. J. Brereton on Turnouts; R. V. A. Norris on Anthracite Mine Surveying; and there are several other artices of interest in their respective lines.

In the number of HARPER'S WEEKLY for July 26 there is a spirited sketch of one of the new battle-ships for the Navy as it will appear when completed. The WEEKLY has reflected the popular interest in the Navy, and has had from time to time excellent illustrations of the new ships. The same paper for August 13 has a sketch and description of the 7,300-ton cruiser, and the number for August 20 has an illustrated description of the manufacture of heavy guns for the Navy.

In the ARENA for August Professor N. S. Shaler has an interesting article on the Economic Future of the South. There is an excellent article on Foreign Immigration, and others on various timely topics. This magazine, indeed, has always something worth reading; its articles are usually on live questions, and whether we agree with the writers or not, we are forced to admit the ability and suggestiveness with which their views are presented.

There will be found in BELFORD'S MAGAZINE for August, besides the usual assortment of fiction and lighter matter, articles on the Original Package Decision, by B. J. Sage, and on Canada under Protection, by Hon. J. W. Langley. A paper on Literature in Louisiana, by Judge Gayarré, is very interesting for the general reader.

In HARPER'S MAGAZINE for September the article Across the Andes, by Theodore Child, is an illustrated description of the great South American Transcontinental line which will, when completed, extend from Buenos Ayres to the Pacific at Valparaiso. This is the first of a series of articles on the South American republics. The Mountain Passes of the Cumberland, by James Lane Allen, is an account of the growth and development of the rich iron region of Kentucky and Southwestern Virginia.

Engineers, and others also, will find Dr. Groff's article on Sanitary Work in Great Disasters, in the POPULAR SCIENCE MONTHLY for August, of much interest. In the same number Robert H. Scott writes of Thunder Storms, and Dr. Klein of Invisible Worlds. In the September number F. J. H. Merrill —in Barrier Beaches of the Atlantic Coast—gives an account of the building up and washing away of the narrow sandy islands near Sandy Hook, Long Branch and Cape May, illustrating similar action that is going on all along our eastern shores.

In the OVERLAND MONTHLY for July the articles on Corporations, Trusts, Labor and Capital are concluded. The OVERLAND is always interesting reading to those who wish to know something of social and economic conditions on the Pacific Coast.

Among the articles in the STEVENS INDICATOR for July are Notes on Friction of Engines, by Professor J. E. Denton; Fabrication of 12-in. Mortars, by A. A. Fuller and F. N. Connet; Identification of Dry Steam, by F. E. Idell; Examination of Lubricating Oils, by Professor T. B. Stillman; Cable Traction for Elevated Railroads, by C. W. Thomas: New Method of Extracting Cube Root, by Professor H. A. Wood; New Recording Pressure Gauge, by Professor W. H. Bristol. This number will be of interest to graduates of the Stevens Institute, as it gives a full report of the Commencement and Alumni meeting.

THE NEW BATTLE-SHIPS.

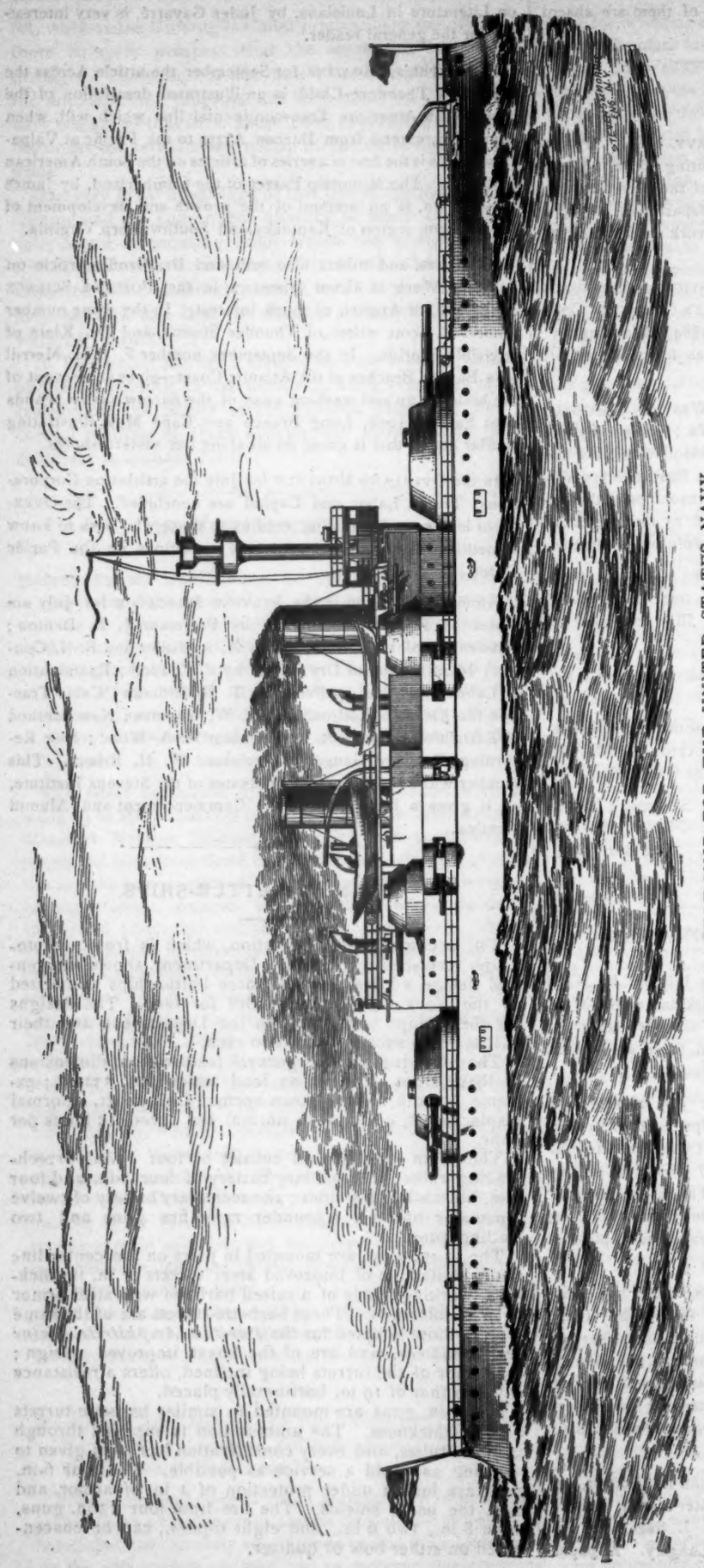
THE accompanying illustration, which is from a photograph furnished by the Navy Department, shows the general design adopted for the three battle-ships authorized by the Navy Appropriation Bill for 1890. The designs for these ships were made in the Department, and their cost is not to exceed $4,000,000 each.

The following are the general features and dimensions of these ships: Length on load water-line, 332 ft.; extreme breadth, 69 ft.; mean normal draft, 24 ft.; normal displacement, 9,000 tons; normal sea speed, 15 knots per hour.

The main battery will consist of four 13-in. breech-loading rifles; the auxiliary battery of four 8-in. and four 6-in. breech-loading rifles; the secondary battery of twelve 6-pounder and six 1-pounder rapid-fire guns and two Gatling guns.

The 13-in. guns are mounted in pairs on the center line under protection of improved steel turrets 17 in. in thickness, working inside of a raised barbette with steel armor 17 in. in thickness. These barbette-turrets are of the same type as those adopted for the *Puritan*, *Amphitrite*, *Maine* and *Monterey*, and are of the latest improved design; the armor of the turrets being inclined, offers a resistance equal to that of 19 in. horizontally placed.

The 8-in. guns are mounted in similar barbette-turrets 6 in. in thickness. The ammunition is supplied through armored tubes, and every consideration has been given to realizing as rapid a service as possible. The four 6-in. guns are fought under protection of 4 in. of armor, and have the usual shields. The fire from four 13-in. guns, three 8 in., two 6-in., and eight 6-pdrs., can be concentrated on either bow or quarter.



THE NEW BATTLE-SHIP FOR THE UNITED STATES NAVY.

The water-line is protected by a belt of steel of a maximum thickness of 18 in., backed up by wood, behind which are two thicknesses of 3.4-in. plates powerfully stiffened by a system of vertical and horizontal girders. Above this belt is a casement of 5½-in. armor to prevent riddling above the belt, and to break up projectiles charged with high explosives. Diagonal bulkheads are worked at the ends of the belt, and from the armored deck, which is worked over the vessel at top of belt, rise the redoubts, protecting the turning and loading gear of the turrets for the heavy guns. A deep belt of coal is carried above the armor-deck, adding still further protection against gun fire.

In wake of the boilers are four skins and a 12-ft. bunker of coal, making it practically impossible for a torpedo to make a hole that will let water into the fire-room.

Behind the armor of the belt and surrounded on all sides by coal are two wide passages, one on each side, connecting the passing rooms for ammunition at the ends, so that all the handling of ammunition will be well protected, and in these passages, lighted by electricity, the men can carry ammunition to the various tubes and trunks leading to the guns above.

The machinery for these ships has been designed by the Bureau of Steam Engineering. The twin screws will each be driven by a vertical triple-expansion engine, each engine being placed in a separate water-tight compartment. The cylinders will be 34½ in., 48 in. and 75 in. in diameter and 42 in. stroke. Steam will be furnished to them by four double-ended main boilers 15 ft. in diameter, each having eight furnaces. Each boiler is in a separate water-tight compartment. In addition there will be two auxiliary boilers 10 ft. in diameter and 8 ft. 6 in. long, placed on the berth deck, from which the pumps and other auxiliary machinery can be run.

The engines are expected to develop 9,000 H. P. under forced draft and 7,000 H. P. under natural draft. The working pressure of steam is to be 160 lbs., and the engines will make 128 revolutions per minute when working up to their full power.

The vessels are to be built on the bracket system, with a double bottom extending from armor-shelf to armor-shelf, with many subdivisions and water-tight compartments. Every approved device adding to the health of the crew, the safety of the ship, and the efficiency in battle will be fitted. Each battle-ship will carry 450 men, including a marine guard of 36 men, and 30 officers. Especial attention has been paid to the ventilation and drainage. Any compartment can be quickly cleared of water in a short time by powerful hand and steam pumps, while air will be supplied to all the living and storage spaces by fans of ample capacity.

REPAIRING BRIDGE PIERS UNDER WATER.

(Note by M. Rossignol in *Les Annales des Ponts et Chaussées.*)

THE Bridge of Joigny, on which the National Road No. 6 crosses the Yonne, was constructed about the middle of the eighteenth century. Since that time it has undergone different changes. The road was widened by substituting an iron railing for the old stone parapet. The approaches have been improved. On the right bank a tow-path and a river arch were united by replacing two smaller arches by a single one, but no change and no repair seems ever to have been made to the foundations.

No record could be found relative to the method employed in building these foundations, but from the reports of boatmen who had dived down alongside of the pier, they appeared to be in a bad condition, and in the course of the year 1886 it was deemed prudent to have them examined by a diver.

This examination revealed the fact that in four piers out of five there were considerable failures. Moreover, the reports given by the diver on the first examination and other examinations, subsequently made when the repairs were begun, enabled the engineers to see in a sufficiently exact way the original arrangements of the foundation. These were similar for all the piers, and are shown in the accompanying illustrations. Fig. 1 is a plan of one of the piers divided into four quarters, that marked *W* being a quarter-section on the line of the framework of the timber platform ; *X* on top of the platform ; *Y* at the springing of the arch, and *Z* at the top of the piles. Fig. 2 is a section through the pier and foundation on the line *A B*, fig. 1 ; and fig. 3 is a cross-section on the line *C D*, fig. 1.

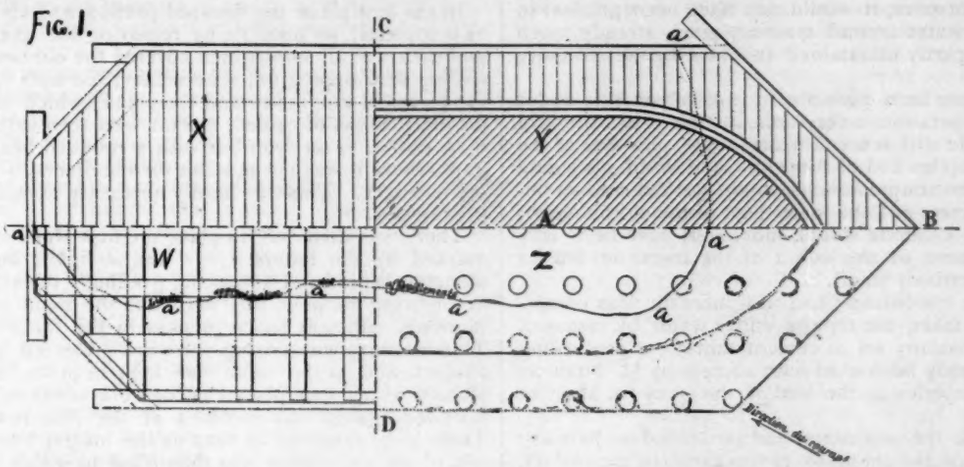
The masonry rested on a system of piling topped by a timber frame and a platform of planks, the upper face of which is 2.85 m. (9.35 ft.) below the level of the Joigny Dam, or about 1.25 m. (4.10 ft.) below low water mark.

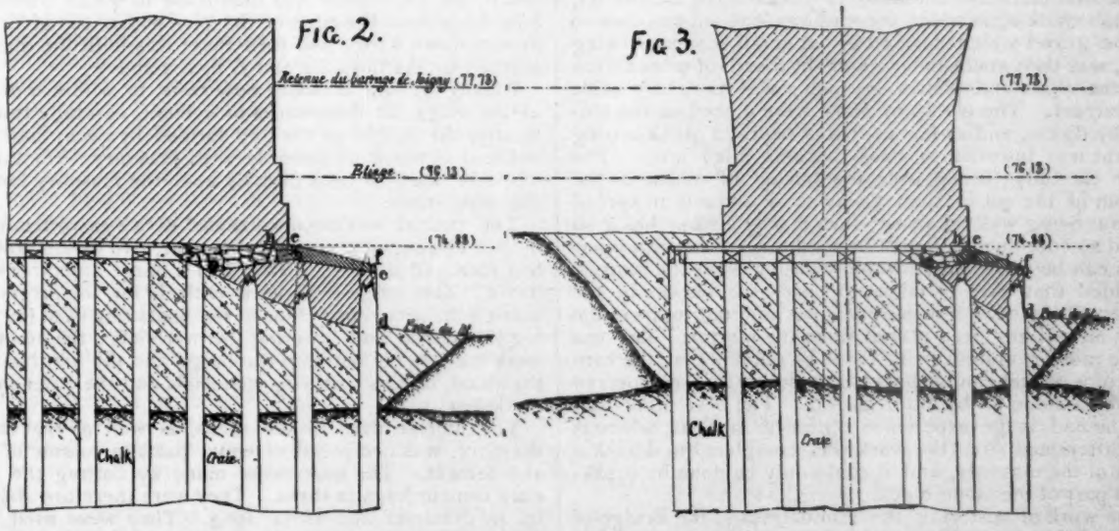
The piles were embedded in concrete, but no remains of braces nor of planks were found indicating the arrangement of any frame or bed in which this concrete could have been placed to set. It therefore seems probable that when the bridge was built the engineers simply dredged out the gravel around the piles in such a way as to lay bare the chalk which forms the bed rock, and is 3 or 4 m. (9.84 or 13.12 ft.) at least below the low-water mark, and after the driving of the piles, beton was run into the hole thus formed. They could then have placed upon the concrete a small coffer dam in such a way as to enable them to pump out the inside, to set the piles, put in the concrete, build the frame and the platform, and finally build the masonry up to the level of the water.

The axis of the bridge is somewhat oblique in relation to the general direction of the bed of the river, in such a way that the current would act very slightly except upon the breakwater of the pier and on the left side of the piles. The result was that the right side of the foundation remained intact and was even partly covered by gravel washed up from the bed of the river, while the piers 2, 3, 4 and 5 were considerably undermined under the breakwater on the left side and even under the lower point of the pier on the line *a a a*, fig. 1.

The action of the current had been almost the same on all of the piers. The illustrations herewith given show as exactly as possible the effects on the foundation of pier No. 2, which was one of the most damaged.

The concrete was worn away by the friction of the gravel, and cracks produced by the eddies under almost all the surface of the breakwater, under the left side of the pier, and under a part of the starling. The piles set under the breakwater, with the first two rows under the left side





and the frame and planking which surmount them were very much decayed, and presented before the restoration of the foundations the form shown by the dotted lines in figs. 2 and 3. These pieces did not offer any sort of resistance, and the masonry over the decayed portion was really resting upon no foundation.

It was necessary, therefore, in order to restore these foundations, to proceed to a rebuilding and to protect the new masonry either by riprap or by additional masonry.

The last solution presented a double advantage. A water-table or bench of masonry resists a strong current much longer, while the riprap is rapidly displaced, and the old surface could be used safely for a foundation. Moreover masonry takes less space and consequently diminishes less the clear opening left under the arches for navigation.

To build this masonry dry, however, it would be necessary to make coffer-dams, which would have been expensive, since the chalk is at a considerable depth and is full of cracks. Moreover, it would not have been prudent to pump out the water around masonry piers, already much damaged and partly maintained in place by the pressure of the water.

It would have been possible to put in concrete under water. This operation, a very delicate one in itself, would have been made still more difficult by the presence of the remains of the piles and of the frame, and besides it would have been almost impossible to obtain perfect contact between the concrete and the lower part of the old masonry. The setting of concrete would, moreover, have been very costly, on account of the extent of the frame needed for a cube comparatively small.

Under these conditions Chief Engineer de Mas considered it best to make the repairs under water by means of divers, with masonry set in cement mortar, a proceeding which had already been used with success by M. Bonneau to repair the injuries to the wall of the Quay St. Maurice et Sens.

In that work the engineers had proceeded as follows: In the first place, the old masonry was carefully cleaned off, and the chalk upon which the wall was founded was cleared of the gravel which covered it. A small screen, or wing dam, was then made under water, by means of piles driven into the chalk and planks, in such a way as to turn aside the current. The blocks of stone were placed on the bottom by divers, and as fast as it was required quick-setting cement was lowered in small buckets filled level. The diver carefully turned over the bucket of mortar at the bottom of the pit in such a way as to allow it to spread without being washed away; then placed a stone block on it and so continued. It will be readily seen that this operation can be carried out without washing away the mortar, provided that care is taken to carry the bucket to the proper place before turning it over and not to move the stone after it has been placed upon the mortar. The use of the mortar, moreover, is made so quickly that the contents of a bucket cannot begin to set before they are covered over by a stone or by more mortar. The best proof that can be had is the experience obtained at Sens, where it was attempted after the work was completed to detach a block of the masonry, and it could only be done by breaking a part of the stone block.

The work of restoring the foundations at the Bridge of Joigny differed a little from that executed on the quay wall at Sens. The decay extended to a greater depth, and it would have been much more difficult to put in the masonry there, since the diver was obstructed by the remains of the piles and of the frame, which he had not been able to remove. It was therefore thought best to ram down sacks filled with cement mortar in all those parts which were not easily accessible. In doing this the engineers were assured beforehand that they would not have to fear the washing out of the mortar and that they could fill the gaps completely. By way of trial they had worked in some sacks of cement with blocks of stone in a large tub, and on examining it several days afterward they ascertained that there was no sensible washing away, that the mortar had set perfectly and that the sacks had molded themselves exactly to the stones.

Moreover, such masonry as had been built at Sens could be given only a very slight inclination, since it was necessary to allow the mortar to take its natural form. It was not thought after what had been seen at the Bridge of Joigny that it would be possible to obtain an inclination of more than 1 : 3 or 1 : 4. Under these conditions part of the advantage of the substitution of masonry for riprap would have been lost at considerable heights, since it would have been necessary to extend this masonry to a considerable distance from the piles, and moreover, part of it must have been founded on the gravel outside of the solid bottom formed by the old beton. Lastly the current at Joigny was much more rapid than at Sens, and it was a difficult matter to turn it aside by means of movable screens. The workmen themselves were led in the course of the work to propose to build the masonry in coffer dams made by nailing horizontal planks upon vertical joists fixed on the remains of the piers of the first line. The work was at last organized, as will be described below, taking pier No. 2, which is shown in the illustrations, as an example.

In the first place the decayed portion was cleaned away as completely as possible by removing the gravel, stones and débris of all sorts which covered the old beton and by cutting or chopping off, if necessary, the ends of the piles, the pieces of the frame, and the planks which could be removed. Sacks of cement mortar were then carefully rammed down, by an iron bar with a rounded head, into the gaps where it was not possible for the divers to reach with the masonry. This was hardly necessary except under the breakwater.

There was then put in place the first block of masonry marked by the letters *o*, *b*, *c* and *d*, figs. 2 and 3, commencing behind and advancing gradually toward the front, and leaving between this mass and the main body of the pier only sufficient space to pass in the sacks of mortar. This masonry was during the work protected against the current, and at the same time kept in place laterally, by planks, which were placed as the work advanced, and were fastened against the remains of the first row of piles. These were removed as soon as the mortar had set. The rest of the excavation was then filled to within about 6 or 8 in. back from the edge of the pier with sacks of cement mortar down hard; and then there was built the masonry marked by the lines *h e* and *f*, figs. 2 and 3.

Finally the old masonry now rests, to within 6 or 8 in. of the edge, on these sacks of cement, carefully rammed in after the height of the gap formed by decay had been reduced as much as possible with masonry. On the last 6 or 8 in. the pier rests directly upon the masonry forming the water-table.

The staff of workmen consisted of a superintendent, a master mason, who mixed the mortar, two divers, and five boatmen and laborers. They had a barge and three small boats. The barge was used entirely for the divers, and carried the air-pump. One of the boats was used for making the mortar and lowering the materials; the other two were used to ply between the barge and the first boat and the shore, one for carrying materials and the other for the workmen.

The mortar used in the sacks, as well as that for the masonry, was composed of equal parts in volume of sand and cement. The sacks were made by cutting the ordinary cement bags in three. They were therefore about 12 in. in diameter and 16 in. long. They were used altogether for four piers about 150 cub. ft. in the sacks and 1,980 cub. ft. of masonry, containing on an average one-third stone blocks for two-thirds of cement. The cost per cubic meter amounted to about 95 fr., including therein all the preliminary expenses, such as the clearing of the foundations, the building of screens and coffer-dams with the loss of time and damage occasioned by floods.

When the work proceeded steadily they were able to make about 3 cub. m. (107 cub. ft.) of masonry a day, the cost being divided as follows: Labor, 75 fr.; use of boats, etc., 5 50 fr.; material, 56 fr.; a total of 137.50 fr., being nearly 46 fr. per cubic meter, or 25.1 cts. per cubic foot.

Really, in consequence of some losses of mortar, not quite 3 cub. m. a day of masonry were obtained, and it is probable that the cost per cubic meter was a little higher than that given, but it did not exceed 50 fr., or 27.3 cts. per cubic foot. In the total cost given above of 95 fr., it therefore appears that about 52.6 per cent. was the cost of

the masonry itself, and the remaining 47.4 per cent. was that of the other expenses.

As to the sacks of cement rammed down in the excavations, it was possible to use only about 1 cub. m. a day, the cost being for labor, 76 fr.; for use of boats, etc., 5.50, and for material, 43.50 fr.; a total of 135 fr., or about 73.4 cts. per cubic foot.

The work lasted about 66 days—from June 1 to August 10—in spite of three or four interruptions, one of which lasted 10 days, being occasioned by a heavy freshet.

Masonry built under water by a diver can be employed with advantage to repair foundations where only a small amount of masonry is required, and where it can be founded either upon hard bottom or old masonry. The application of this process requires only a small plant, and does not require navigation to be obstructed, and while it cannot be claimed that masonry thus built is quite equal to that built in the open air, it can at least be said that it gives results much better than with concrete made under water.

The use under water of sacks of cement mortar appears also in certain cases to be capable of an excellent application. It is probable that no other process will permit work under water to be repaired which will secure so perfect a contact with old masonry.

Another example may be cited in which the use of sacks of cement has rendered real service. The viaduct which is now being built across the Loire for the railroad from Bourges to Gien has the foundations of the piers in pits, which are dug through a water-bearing sand to the marly limestone which forms the subsoil of the valley. In some of these excavations the bottom is disturbed by violent currents of water coming either from the water-bearing sand into the pit, or from cracks, which are frequently met with in the limestone, and the waters of which spout out in the bottom of the excavation. This water could not be carried away by masonry channels or drains since the mortar would be at once washed out. The use of cement in sacks allows the engineers to obtain a pavement or foundation for the bottom of the pit almost solid and fitting itself perfectly to all the irregularities of the bottom, thus allowing the concrete to be set with perfect security.

It sometimes happened that the quantity of water is so great and the points to be attended to so numerous, that it is impossible to carry off the water in drains. Besides it was found necessary to cut down the little stumps which are found thickly scattered in the ground in that neighborhood, and these were covered with water. It would be possible, it is true, in such a case to make a ring of dry masonry and set concrete within it, but this ring of masonry would rest upon the ground very unevenly and would not fill properly the gaps remaining between the stumps. With sacks of mortar, on the other hand, there could be formed in the submerged excavations a foundation perfectly fitted to the bottom and surrounding the beds of the stumps up to the surface of the water. The water could be allowed to pass out by a series of channels which could be made in placing the sacks, and the concrete could be set on top of it without fearing that it would be washed away.

For this purpose the mortar must have a different composition from that adopted at Joigny. The quantity to be employed in a given time is too great to proceed by mixing small quantities. Mortar would then be made in large quantity, and, as a certain time is needed to place it in sacks and carry it to place, it was necessary to use a slower setting cement. For that purpose there was used a mortar the proportions of which were 450 kg. of Vassy cement; 150 kg. of Theil chalk and 1 cub. m. of sand. It can be said from experience gained in conditions entirely similar to those of the work executed at the bottom of the pits, that the cement will not be sensibly washed away. There were placed in a trench, in the line of flood of the water where the current was quite strong, sacks which the workmen had shaped upon one another by stamping them down, forming conduits to the interior of the body thus formed, and which were filled entirely with stones. The sacks taken out after a certain time were perfectly formed one upon another. In those which were compressed on all faces the mortar had not suffered the least washing out. In those forming the channels the mortar on the side toward the channel was very slightly washed away, but this result was altogether superficial, and did not affect the solidity of the cement inside.

Moreover, in December, 1888, a certain number of sacks was rammed down in the bottom of the excavation in a rocky cavity, from which the water came out with considerable force. This excavation was abandoned during the winter and the work resumed in the month of April, 1889, when it was found that although the sacks had been driven down in the middle of a spring of water, the cement had set perfectly without being washed away, and most of the sacks were so well set into the holes and irregularities that it would be impossible to remove them. It can then be concluded from those trials that the sacks of cement, the usefulness of which has already been approved for repairs to foundations, can also be very conveniently employed at the bottom of excavations traversed by currents of water to make channels or even surfaces, under which the water can be completely covered in such a way as to permit the concrete or foundation masonry to be set dry.

It may, however, be remarked in a general way that if the use of mortar in sacks allows us to avoid completely the washing away under the most unfavorable circumstances, the interposition of the cloth of the sack has at the same time the effect of preventing the adherence of the different parts of this sort of masonry. Under pressure the cloth will only allow the escape of a little matter, which does not make a joint. It consists, therefore, in fact, of only dry masonry, but it is dry masonry presenting this advantage, that the joints are infinitely small in consequence of the facility with which the sacks can be made to take different shapes.

This absence of adherence of the different parts has, moreover, no inconveniences under the circumstances in which it has been used. At the Bridge of Joigny it is in fact completely covered by the masonry. At the viaduct of Gien it is found at the bottom of the excavations in a valley which is only covered at the highest floods of the Loire and at such depths that injury is not to be feared.

It is believed that in similar cases the use of sacks of cement may render real service, and it is for this reason that it has been considered interesting to give details of the applications which have been made of this process.

AERIAL NAVIGATION.

By O. Chanute, C.E., of Chicago.

(A lecture to the students of Sibley College, Cornell University; delivered May 2, 1890.)

(*Continued from page 367.*)

POSSIBLE IMPROVEMENTS IN BALLOONS.

Before expressing an opinion upon the future speed of navigable balloons it may be interesting to review the various difficulties which have hitherto been met, and to inquire into what patent attorneys call "the state of the art."

The greatest speed thus far attained has been 14 miles per hour, which, as indicated at the beginning, is insufficient to cope with most of prevailing winds, particularly at sailing heights above the ground, and the following difficulties have been encountered and, to a certain extent, overcome.

1. Excessive loss of gas in early experiments.

This has been remedied by closer tissue of envelope and better varnishes, as well as by regulating valves, so that the loss of gas at the captive balloon in Paris last summer was said to average less than 2 per cent. per day.

2. Resistance of air to forward motion.

This has been largely diminished by pointed ends, but much remains to be done in ascertaining the best proportions.

3. Need of a propeller to act on the air.

This has been measurably solved by the aerial screw, which is said to exert from 50 to 70 per cent. of the power applied, but is yet less efficient than the marine screw, which works up to 84 per cent.

4. Need of steering gear.

This has been fairly worked out by various arrangements of rudders and keel cloths, which have given command of the apparatus when in motion.

5. Need of a light motor.

This is the great difficulty. Steam has been tried with a weight of 154 lbs. per H. P., including fuel and water, and electric engines with a weight of 130 lbs. per H. P. Neither are sufficiently light to give the necessary speed, except, as will be explained, for very large apparatus.

6. Need of endwise stiffness.

This has been remedied by compressing the gas inside the balloon, either through the use of a loaded safety valve or through the use of an internal air bag. As speed increases more will needs be done in this direction, and this will require stronger and heavier envelopes for the gas bag.

7. Need to prevent deviations in course.

This has been overcome by placing the screw in front, where it is more effective than behind.

8. Need of longitudinal stability.

This has only been partly solved by various methods of suspension. There is still a tendency to pitch when meeting gusts of air, and this will increase when greater speeds are attained. It will need to be worked out by experiment.

9. Need of altitudinal stability.

This is the tendency of the balloon to rise or fall with the heating or cooling of the gas. It has been met in only a crude way by alternately discharging either gas, to prevent the balloon from bursting, or ballast, to prevent it from coming down. This rapidly exhausts both gas and ballast, and limits the time of the trip.

It has been repeatedly proposed to substitute for this method a vertical screw, to raise and depress the balloon, which should then be at starting slightly heavier than the air which it displaces; and one of the best proposals for this purpose is due to an American engineer, Mr. E. Fal connet, who patented it in 1885, together with many other features, to remedy the various difficulties which have been encountered; but death cut short his labors, and his devices have never been experimented on.

The great desideratum is to gain increased speed, and there are at least four ways by which this may be accomplished.

1. By giving the balloon a better form of hull, so as to diminish the resistance. *La France* was rather blunt in front, and there is reason to believe that by simply moving the largest section further back, increased speed will result.

2. By designing a more efficient aerial screw. Commandant Renard has been experimenting in this direction, and says there is a shape much better than others, and that this form cannot be departed from without getting very bad screws; falling, as he expresses it, into a veritable precipice on either side.

3. By devising a lighter motor, in proportion to its energy. This is the great field in which work remains to be done. It was announced in September, 1888, by a newspaper correspondent that Commandant Renard had built a motor weighing 1,100 lbs. and developing 50 H. P., but since then nothing has been heard of it.

4. By simply building larger air-ships, for, inasmuch as their contents, and consequent lifting power, will increase as the cube of their dimensions, while their weight will, approximately, only increase as the square, the surplus lifting power will evidently increase with the size, and greater motive power in proportion can be used.

Let us suppose, for the sake of this argument, that no improvement whatever has been achieved in either of the first three ways which have been mentioned, and inquire simply what would be the effect of doubling the dimensions of *La France*. The comparison will be approximately as follows:

Principal Dimensions.	*La France.*	Double Size.
Length, out to out..... ft.	165	330
Diameter, largest section..... "	27.5	55
Contents of gas.....cub. ft.	65,836	526,688
Lifting power.....lbs.	4 402	35,216
Weight of apparatus..... "	2,451	9,804
" Cargo and aeronauts..... "	779	1,500
" Machinery..... "	1,174	23,912

As the motor (dynamo and battery) of *La France* weighed 130 lbs. per H. P., we have for that of double the size $\frac{23,912}{130} = 182$ H. P. motor, and calculating the speed by the formula of Commandant Renard, and inserting the new diameter, 16.8 meters, we have:

$$T = 0.0326 \times \overline{16.8^2} \times V^3 \text{ in kilogrammeters.}$$

But as we have 182 H. P., and there are 75 kilogrammeters in the H. P., we have further:

$$182 \times 75 = 0.0326 \times \overline{16.8^2} \times V^3,$$

$$\text{whence } V = \sqrt[3]{\frac{13650}{9.2}} = 11.2 \text{ meters.}$$

So that we see that the speed of the new air-ship will be 11.20 meters, or 36.7 ft. per second, say 25 miles per hour.

The same result is arrived at by considering that the new balloon will require four times the motive power of *La France* to go at the *same speed*, and that the power required increases as the cube of the speed. So that we see that a speed of 25 miles per hour is even now in sight, without any other improvement than doubling the size of the balloon.

It will not be safe to assume, however, that increased speed can be indefinitely obtained with mere increase of size, because with more speed a series of new difficulties are likely to arise, and some of the old ones to be aggravated.

The first of these will probably come from the lack of longitudinal stiffness. Although it has been found that a certain amount of internal gas pressure gives the elongated balloon sufficient rigidity to resist the pressures due to low speeds, so soon as these are increased there may be a tendency to buckle, twist and collapse, and this means more pressure, a stronger envelope and more weight; or a rigid internal frame, as proposed by Mr. Falconnet; and this also means much more weight.

Next, there will be in great balloons much greater difficulty in distributing equally the weight of the car and its contained motor over the gas-bag, because of the necessary greater concentration of weight in the car. It will besides be found more difficult to apply the propelling power near the line of equilibrium, so as to avoid oscillations.

There will also be increased difficulty from the flow of the gas back and forth inside of the elongated balloon, thus displacing its center of gravity, and threatening the danger which so nearly proved fatal to Giffard. Moreover, even slight changes of outer temperature, heating and cooling the gas in the balloon, and thus charging its ascending power, are likely to be far more troublesome when operating on large than on small masses of gas, so that it seems likely that large balloons will be found more unstable, both vertically and logitudinally, than the comparatively moderate sizes which have so far been experimented upon.

These difficulties can all be surmounted, no doubt, including the remaining one that large balloons will be costly, and that few can afford to experiment with them; but the various appliances necessary for stability will involve more weight, and this again will require more size.

Be this as it may, it is evident that somewhere a limit will be reached beyond which unmanageable sizes will be met with. The weight, the size, the resistance will increase, as well as the speed, and somewhere there will be impracticability. We have seen that to go 25 miles per hour, and thus brave the wind about three-quarters of the time, we need an elongated balloon similar in shape to *La France*, 330 ft. long and 55 ft. in diameter. It is probable that, by improvement in the first three ways which have been mentioned, it may attain a speed of 30 or 35 miles per hour; but when it is attempted to obtain 40 miles per hour out of it it will grow to lengths of, say, 1,000 ft., or as long as four ordinary city blocks, and diameters of 150 ft., or the height of an ordinary church steeple.

These seem unmanageable and impracticable sizes for ordinary uses. They are greater than those of ocean steamers, because the speed required is greater, to overcome the

aerial currents; and the care and maintenance of these great air-ships will be a difficult matter.

It seems likely, therefore, that in the near future elongated balloons will be built which will be driven at 25 or 30 or a few more miles per hour, which will be able to sail about on all but stormy days; but the cargoes carried in proportion to the size will be small, and to obtain speeds similar to those of express trains some other form of apparatus will have to be sought for.

(TO BE CONTINUED.)

THE SECOND SECTION OF THE GREAT SIBERIAN RAILROAD.*

BY A. ZDZIARSKI, ENGINEER.

THE second link in the Great Siberian Railroad is the Oufa-Zlatooust Railroad, which is 200 miles in length, traversing the secondary ranges of the Oural Mountains and crossing many mountain streams. The location was begun in the summer of 1886, and was very interesting work on account of the many difficulties met with. It required much time and money, and was completed finally not without some faults, especially on the first section of 20 miles, where the crossing of the divide between the White River and the Oufa may be considered obviously superfluous.

In addition to the fact that this line is part of the great through road, it was important on account of the development of the local mining industry, which has hitherto been very slow.

The preliminary exploration was made in 1884 by a commission including representatives of the departments of Internal Communication, of Finance and of Crown Domains. The final location, however, was made from surveys completed in 1886 and 1887, and was immediately followed by the construction, which began in 1888. According to this location the line starts from the Oufa station of the Samara-Oufa Railroad and runs down the right bank of the White or Bielaia River, crossing a very broken country. It is here generally a hill-side line with heavy rock cutting and high fills, and as the soil is intersected by layers of gypsum, there were enormous shrinkages in these fills. The line then rises to the divide between the White and the Oufa Rivers and descends into the valley of the latter river, crossing it with a long iron bridge having three spans of 350 ft. each. After crossing the Oufa the line follows the left bank of that river, then turns up the valley of its tributary, the Lobau, and crosses the divide into the valley of the Sim. Crossing this river it follows its right bank to Lake Miniar, near the Miniar Iron Works, and ascends the valley of the Eralka River until it reaches the divide between the Sim and the Urezan, crosses this and then follows the valleys of the Little and Great Berdiash successively, until it reaches the main stream of the Urezan, which it crosses by a bridge of 280 ft. span, and then follows to the mouth of the Vrazow-Kluch; then ascends the valley of that stream nearly to its head and crosses another divide into the valley of the I. After crossing that river it descends the Tluar, a tributary, and following the slopes of a secondary divide between the I and its tributary, the Great Satka, it crosses the Koukish, Baldauk and Suleia mountain ranges and descends into the Great Satka Valley, crossing that stream to the Berdiash again and descending another divide between the Satka and the I. Descending the Valley of the Tainak and crossing the Kauvash it again reaches the valley of the I, which it follows to Zlatooust.

From this description and from the map and profile accompanying, it is evident that the location was not an easy one. It crosses many divides and some very rapid rivers, and these difficulties have made the length of the line 200 miles, when the distance from Oufa to Zlatooust in a direct line is only 144 miles.

Four of the rivers crossed—the Oufa, the Sim, the Urezan and the Satka—are navigable in spring, and the bridges crossing them had to be designed for a proper elevation above high-water level.

The longest distance between stations is 17 miles; assuming the speed of passenger trains at 20 miles and of freight trains 13½ miles an hour, this would allow two passenger and seven freight trains daily each way without delays.

The maximum grade going westward is 0.85 per cent. and going eastward 1 per cent. The minimum radius of curvature is 1,050 ft., which is somewhat less than on the Samara-Oufa Line.

The cross section of the grade, designed for single track, has a width of 18.2 ft., and is everywhere in the river valleys elevated at least 3.5 ft. above high water. The total quantity of earthwork required is 18,000,000 cub. yds., which is an average of 90,000 cub. yds. per mile. The distribution of this earthwork varies very much, the most difficult portions being the crossing of the divide between the Oufa and the White River, 3.5 miles, where the average rises to 328,700 cub. yds. per mile; the crossing of the Oufa, two miles, about 760,000 cub. yds.; the crossing of the Sim, 1½ miles, about 580,000 cub. yds., and the crossing of the divide between the Urezan and the I River, 1½ miles, where about 570,000 cub. yds. had to be moved. The nature of the soil varies very much, but is generally difficult. Rock and stone cuts amount to about 252,000 cub. yds. The highest fill is 94½ ft. and the deepest cut 68 ft. At a number of points retaining walls are required, amounting in all to about 67,300 cub. yds. of masonry.

As might be expected from the nature of the line, many bridges are required, which may be briefly described as follows:

1. Bridge over the Oufa River 1,050 ft. in length, divided into three spans of 350 ft. each. This bridge is of the same type as the bridge over the White or Bielaia River—that is, a through truss of semi-parabolic system with double intersections.
2. Two bridges of 280 ft. span, one a through bridge over the Sim River of very similar type to the above, the other a deck span, with semi-parabolic lower chord, over the Urezan.
3. Two bridges each of 210 ft. span over the Katav and the Sim rivers.
4. Two bridges of 175 ft. span over the Sim River.
5. A bridge over the Miniar River of 105 ft. span.
6. Iron girders on stone abutments, with spans varying from 14 to 56 ft. in all, 110 in number.
7. Iron girders on stone abutments of 7 ft. span, 85 in number.
8. Wooden bridges with stone abutments, four in number, of 3½ ft. span.
9. Of stone arched culverts there are 94, with spans varying from 3½ to 21 ft.

The masonry on the line is made partly with cement mortar and partly with compound hydraulic mortar.

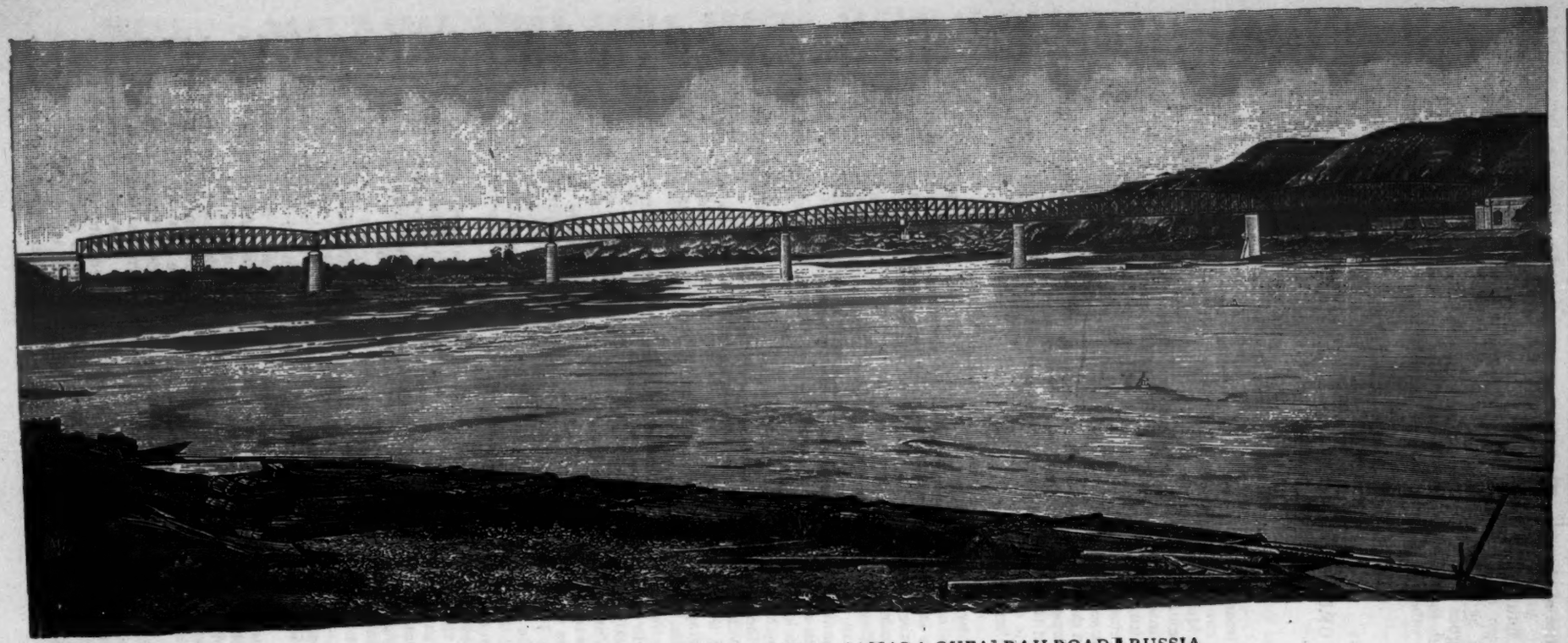
The Oufa Bridge has a clear elevation of 34½ ft. above high-water level. The foundations of the piers and abutments of this bridge rest on six caissons sunk to a depth of 66 ft. below low-water level.

The track presents no peculiarities, but is of the same type as that of the Samara-Oufa Line. The rails are of steel, of two patterns, weighing respectively 65½ lbs. and 58⅜ lbs. to the yard. They are made in one of the Oural iron mills, the Katav-Ivanov Works.

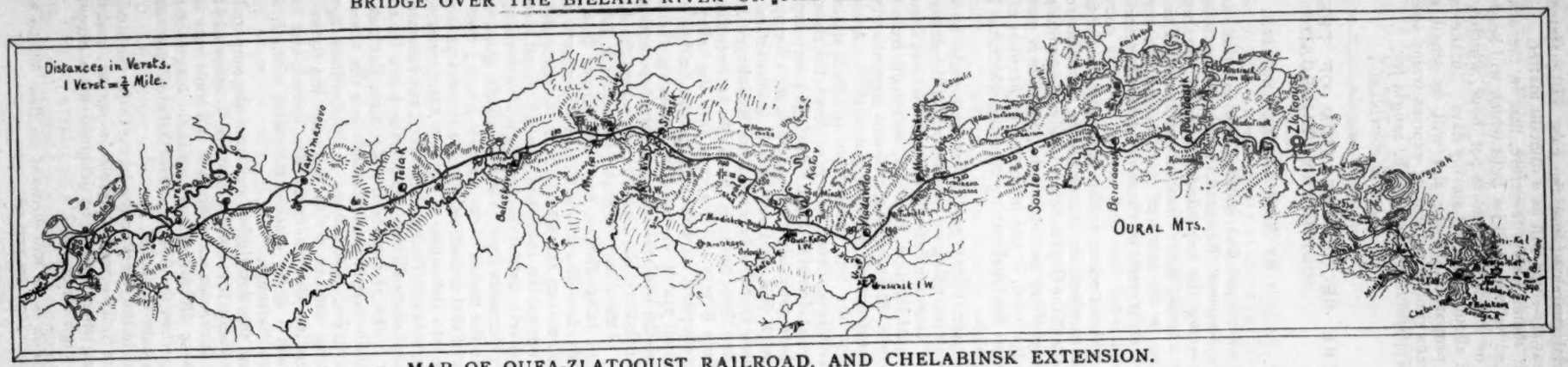
As on the Samara-Oufa Line, and according to the system of track repairs generally adopted in Russia, section houses are provided at each station, and at such intermediate points as are necessary, the average distance between them being 9 miles. In all there are 51 of such houses of different sizes, and besides these 82 small houses are provided for track watchmen. All of these buildings are of wood on stone foundations.

Including the Oufa station there are 17 stations on the line. The greatest distance between them is 16½ and the smallest 7 miles. All of these stations are of wood, on stone foundations, with iron roofs. Their area varies from 1,000 to 3,200 sq. ft. The terminal station at Zlatooust covers an area of 4,900 sq. ft. The country traversed by the road is very thinly inhabited, and it was necessary to provide houses for all the officers and employés. These are generally of a simple type, of wood. There are three engine-houses, one at Asha holding four engines, one at

* See article on the First Section of the Great Siberian Railroad, in the JOURNAL for June, 1890, page 258.

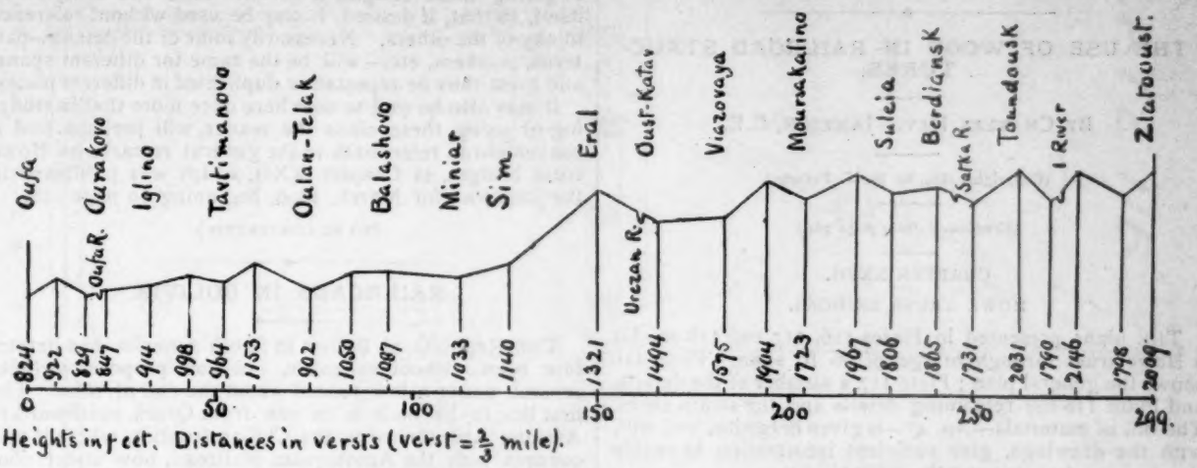


BRIDGE OVER THE BIELAIA RIVER ON THE SAMARA-OUFA RAILROAD, RUSSIA.



MAP OF OUFA-ZLATOOUST RAILROAD, AND CHELABINSK EXTENSION.
SECOND SECTION OF THE GREAT SIBERIAN RAILROAD.

Viazovaia for six engines, and one at Zlatooust, also for six engines. No repair shops are provided, as it is expected that all general repairs will be made at the Oufa shops, built for the Samara-Oufa Railroad, which will be enlarged if necessary. The engine-houses are either of stone or brick with iron roofs. As it was difficult to estimate the traffic of the new line, no freight stations or storehouses have been built, but they will be constructed after the road is opened, when it will probably be easier to ascertain the needs of the traffic.



PROFILE OF OUFA-ZLATOOUST RAILROAD.

The car supply will include 42 passenger cars and 410 freight cars. One-fifth of the total number of freight cars will be provided with brakes. In calculating the car supply the average effective speed of passenger trains is assumed at 17 miles and the freight trains at 8 miles per hour.

In providing the equipment it was calculated that one passenger and two freight trains would be run in each direction every day, with an average of four working trains per week and of an officer's train every month. On this estimated mileage, with an allowance of 20 per cent. for switching, there will be a total engine mileage of 17,360 miles for passenger engines and 33,600 miles for freight engines monthly. In Russia it is usually assumed that a six-wheel or passenger engine will run 1,466 miles and an eight-wheel or freight engine 1,333 miles per month. On this basis 11 six-wheel and 24 eight-wheel engines will be provided. These will be of the ordinary type in use in Russia.

At every station there is water supply provided. At the way stations provision is made for a supply of at least 4,800 cub. ft. daily, and at the stations where there are engine-houses 9,600 cub. ft. daily. The water-tanks, which hold 2,788 cub. ft., are of iron, placed on stone buildings with an upper story of wood covering the tank.

In the construction of this line the work was divided into sections of from 10 to 20 miles in length and also according to the description of work. These sections were let to sub-contractors, the prices being based on the unit of work.

The accompanying map shows the line as built from Oufa to Zlatooust. The dotted line beyond the last-named point shows the more difficult part of the extension from Zlatooust to Chelabinsk, work on which is to be begun this year. The other cut shows the profile of the Oufa-Zlatooust Line.

The Oufa Bridge alone cost 300,000 roubles, or more than one-fourth of the total amount charged to bridges. Amounts which are given in roubles are not converted into American currency for the reasons stated in the previous article—the varying exchange value of the rouble, which we may say is generally assumed at about 60 cents, and the fact that owing to the lower price of labor in Russia the purchasing power of the rouble in work is very nearly equal to that of a dollar in America.

Work on the construction of the Oufa-Zlatooust Railroad was begun in the fall of 1889; about half of the earthwork and masonry was finished in 1888; the remaining half of the earthwork and masonry in 1889, and in addition the iron superstructure of the bridges, most of the bridge erection and about half the tracklaying. The remainder of the tracklaying and the buildings are now in progress, and the line will be open to Zlatooust in the fall of this year.

The cost of the line from Oufa to Zlatooust is calculated as follows:

	Description of Work.	Cost in Roubles.		Per Cent. of Total.
		Total.	Per Mile.	
1	Expropriation, lands, etc.	211,073	1,055	1.04
2	Earthwork	5,890,452	29,452	29.13
3	Bridges	5,023,592	25,118	24.85
4	Track and ballast	4,009,013	20,045	19.84
5	Road accessories	56,681	283	0.28
6	Telegraph	70,563	353	0.35
7	Road buildings and crossings	250,320	1,252	1.24
8	Station buildings	864,084	4,321	4.27
9	Water supply	257,839	1,289	1.28
10	Station accessories	308,250	1,541	1.53
11	Rolling stock	1,608,868	8,044	7.96
12	Branch to Zlatooust Iron Works	10,100	50	0.05
13	General expenses	1,285,536	6,428	6.37
14	Extraordinary expenses	109,558	548	0.54
15	Controlling and police	117,426	587	0.54
16	Sundry works	147,408	737	0.73
	Total	20,220,663	101,103	100.00

The illustration given herewith is a general view of the great bridge over the Bielaia (White) River on the Samara-Oufa line, which was described in the June number of the JOURNAL. This bridge has six spans of 350 ft. each; the piers and abutments are founded on caissons sunk by pneumatic process. The foundation for the piers is 56 ft. below the low-water level, and the foundations of the abutments are respectively 42 and 49 ft. below low-water level. The masonry is of limestone, the up-stream faces of the piers and the ice-breakers being of sandstone. The superstructure was designed by Professor N. A. Beleloubski, and is a through truss of semi-parabolic system with double intersections, somewhat resembling the Linville truss. The chords are of channel shape. The posts are made of four or more separate angle-bars placed at such a distance apart that the floor-beams could be fixed between them. The chief feature of this bridge is that the floor-beams are not riveted to the lower chord, but are carried on special hinges or links, so that the strain from the floor-beams is transmitted to the center of the chord, avoiding all torsional strains of the channel-bars, and therefore the strain on the lower chord is much less. This

system of hanging the floor-beams requires separate cross-girders to connect the lower chords.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C.E.

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(*Continued from page* 361.)

CHAPTER XXVII.

HOWE TRUSS BRIDGES.

The plans presented in Plates 116, 117 and 118 are for a Howe truss through bridge of 66 ft. span. Plate 116 shows the general plan; Plate 117 a number of the details, and Plate 118 the remaining details and the strain sheet. The bill of materials—No. 47—is given herewith, and will, with the drawings, give sufficient information to enable the engineer to construct the bridge.

No. 47. Bill of Material for Howe Truss Bridge, Through Span, 66 Ft. Plates 116, 117 and 118.

Timber.

No. of Pieces.	Description.	Size.	Length.	Ft. Board M's're.	Kind of Wood.
4	Top Chord.....	6 in. × 12 in.	33 ft. 0¾ in.	793	Yellow Pine.
4	" "	6 in. × 12 in.	15 ft. 0¾ in.	360	" "
2	" "	8 in. × 12 in.	26 ft. 0½ in.	418	" "
2	" "	8 in. × 12 in.	22 ft. 0½ in.	353	" "
4	Bottom Chord..	6 in. × 14 in.	40 ft. 0 in.	1,120	" "
4	" " ..	6 in. × 14 in.	32 ft. 0 in.	896	" "
4	" " ..	8 in. × 14 in.	20 ft. 0 in.	747	" "
2	" " ..	8 in. × 14 in.	32 ft. 0 in.	597	" "
8	Braces	12 in. × 10 in.	25 ft. 9¼ in.	2,064	" "
8	"	10 in. × 8 in	25 ft. 9¼ in.	1,384	" "
8	"	9 in. × 8 in.	25 ft. 9¼ in.	1,240	" "
8	Counters.....	9 in. × 7 in.	25 ft. 9¼ in.	1,080	" "
4	"	9 in. × 7 in.	13 ft. 0 in.	277	" "
6	Laterals.....	6 in. × 8 in.	19 ft. 1½ in.	459	" "
10	"	8 in. × 8 in.	19 ft. 1½ in.	1,020	" "
2	"	6 in. × 8 in.	13 ft. 11¼ in.	112	" "
2	"	8 in. × 8 in.	13 ft. 11¼ in.	150	" "
8	Bolsters.....	6 in. × 12 in.	9 ft. 0 in.	432	" "
4	"	8 in. × 12 in.	9 ft. 0 in.	288	" "
8	Bridge-seats....	6 in. × 12 in.	6 ft. 0 in.	288	" "
4	" "	8 in. × 12 in.	6 ft. 0 in.	192	" "
4	Sills.	12 in. × 12 in.	18 ft. 0 in.	864	Spruce or Pine.
20	Floor-beams	9 in. × 16 in.	18 ft. 0 in.	4,320	" " "
6	Stringers.....	6 in. × 12 in.	72 ft. 0 in.	2,592	" " "
62	Ties.....	8 in. × 8 in.	12 ft. 0 in.	.....	Oak.
2	Guards.....	6 in. × 6 in.	72 ft. 0 in.	532	Spruce or Pine.
4	Plank.....	2 in. × 8 in.	72 ft. 0 in.	384	" " "
8	Blocks.....	2 in. × 8 in.	2 ft. 0 in.	24	Oak.

Wrought-Iron—Rods and Bolts.

No.	Description.	Diameter.	Length.	No.	Description.	Diameter.	Length.
8	Rods.	2¾ in.	26 ft. 10 in.	12	Bolster b'lts	1¾ in.	3 ft. 4 in.
8	"	2½ in.	26 ft. 10 in.	20	Fl.beam b'ts	1¼ in.	4 ft. 4 in.
4	"	1¾ in.	26 ft. 10 in.	48	String'rb'lts	¾ in.	2 ft. 6 in.
6	Laterals....	1½ in.	18 ft. 6 in.	28	Tie-bolts.	¾ in.	2 ft. 6 in.
4	" ...	1¾ in.	18 ft. 6 in.	28	G'rd-r'l-blts	¾ in.	1 ft. 3 in.
136	Chord-bolts.	¾ in.	2 ft. 0½ in.	24	Spikes.....	½ in.	9 in.
20	Brace-bolts.	¾ in.	2 ft. 0½ in.				
12	" "	1¾ in.	2 ft. 4 in.				

Other Iron Work.

Washers: 10 of pattern *H*1; 88 of *H*2; 425 of *G*.

Castings: 20 of pattern *A*; 4 of *B*; 16 of *C*; 8 of *D*; 20 of *E*; 4 of *F*; 12 of *I*; 16 of *J*; 56 of *K*; 68 of *L*; 24 of *M*; 6 of *N*; 12 of *O*.

As it may appear that there is some repetition of details in these plans, it may be well to say here that the intention in giving these designs is to have each one complete in itself, so that, if desired, it may be used without reference to any of the others. Necessarily some of the details—patterns, washers, etc.—will be the same for different spans, and must thus be repeated or duplicated in different plates.

It may also be well to note here once more that in studying or using these plans the reader will perhaps find it convenient to refer back to the general remarks on Howe truss bridges, in Chapter XXII, which was published in the Journal for March, 1890, beginning on page 128.

(To be continued.)

RAILROADS IN BOLIVIA.

The Republic of Bolivia in South America has heretofore been without railroads, but now proposes to build several, under a law passed about the end of 1889. The first line to be built is to run from Oruro southward to Ascotan and thence to the Chilian frontier, where it will connect with the Antofogasta Railroad, now under construction in Chili; this is to be completed by January 1, 1892.

A second line is to run from La Paz to the Peruvian frontier. A third will connect Sucre with Oruro and La Paz, and a fourth will extend from Sucre southward to the Argentine frontier.

Other lines proposed are from Sucre eastward to the Paraguay River and from Tarija in the same direction. Lines from Sucre and La Paz northward are also spoken of, but will be the last to be built. Surveys for these lines are still to be made, but no great difficulties are expected, as they will traverse the more level portion of the great elevated plain which forms the larger part of Bolivia.

The law authorizing the construction of railroads provides for a guarantee of 6 per cent. interest on the capital invested in the lines designated by the Government. The stockholders are to have the option of accepting a grant of one square league of land for each league of railroad built, instead of the guarantee of interest.

THE WORKS AT THE KHOJAK TUNNEL.

Reference has before been made to the tunnel by which the Indian Frontier Railroad is to cross the summit at the Khojak Pass in the Himalaya Mountains on its way to Kandahar. The headings in this tunnel, which is 12,600 ft. long, were recently joined. The following account of the actual condition of the tunnel, and the description of the temporary line in use over the Khojak Pass, are given by *Indian Engineering*.

An idea seems to be prevalent that now that the Khojak Tunnel headings have joined, trains will forthwith be able to run through to New Chaman. This is far from being the case; there is still more than half the enlargement to full section to be done, and throughout the whole of this a masonry arch lining will require to be turned, so that fully a year must elapse before there is any prospect of through running being possible.

Meanwhile, the traffic is being carried on by means of temporary lines laid over the hill, and as these exhibit several features of interest, owing to their severity of grade and diversity of system, we publish herewith a drawing showing the whole of them in profile.

When the three rival projects for the passage of the Kwaja-Amran Range were under consideration, it was at first regarded as an objection to the route finally selected that the tunnel, which formed its chief feature, would take from two to three years to construct, and the Government of India considered that it was of paramount importance to establish communication across the range at a considerably earlier date, as in the event of complications again arising in Central Asia a forward movement of troops might be necessary.

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PLATE 116

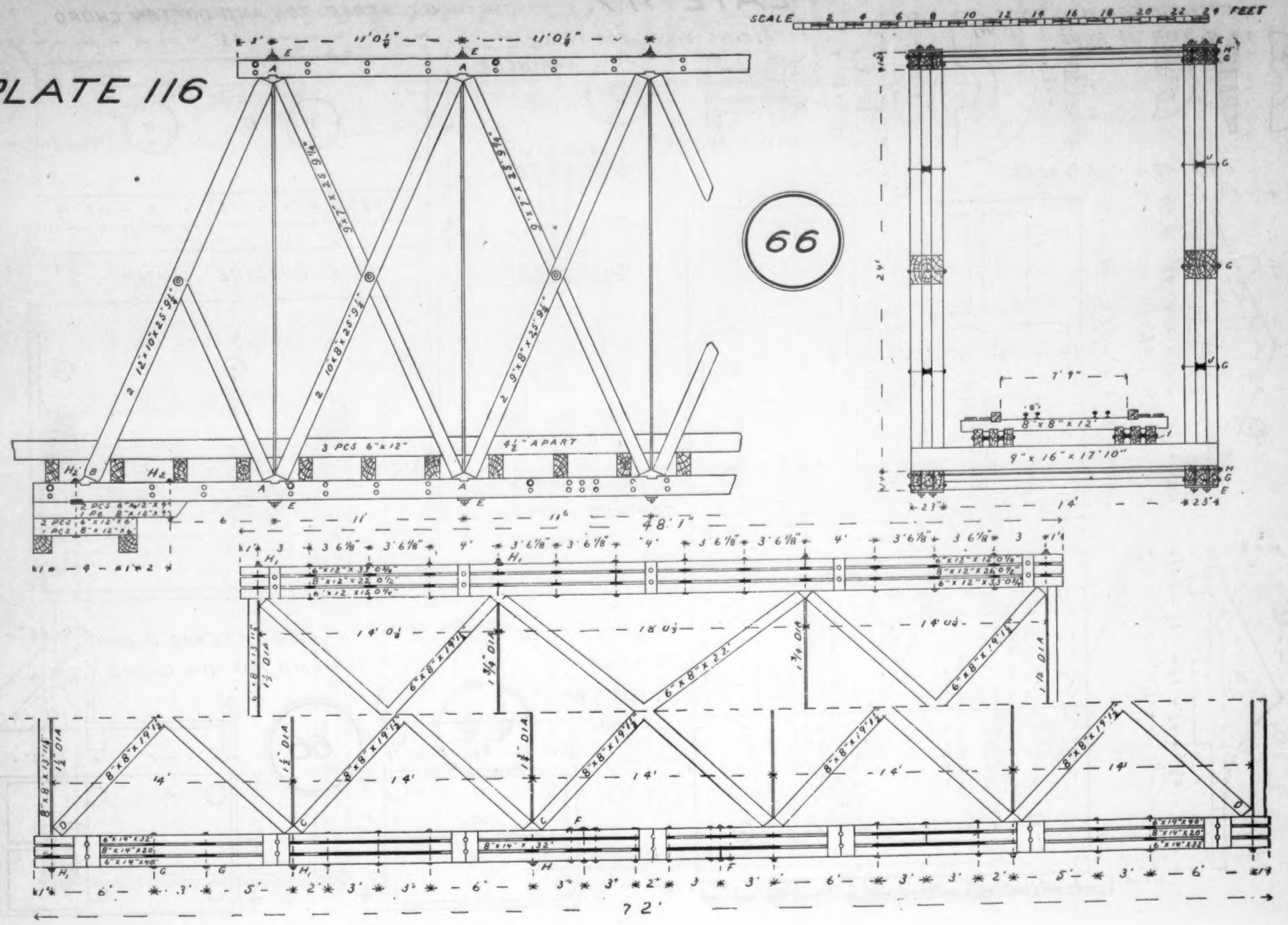
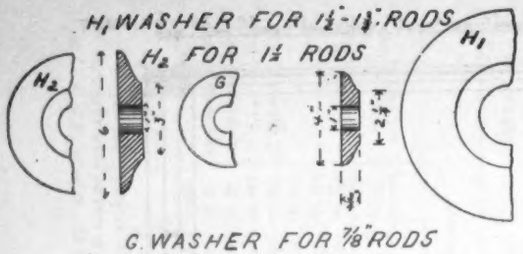
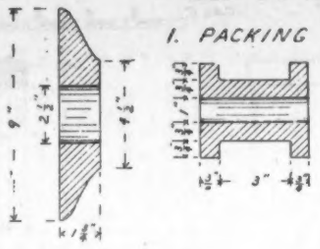
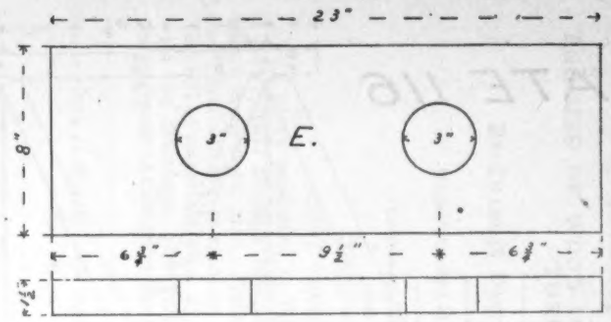
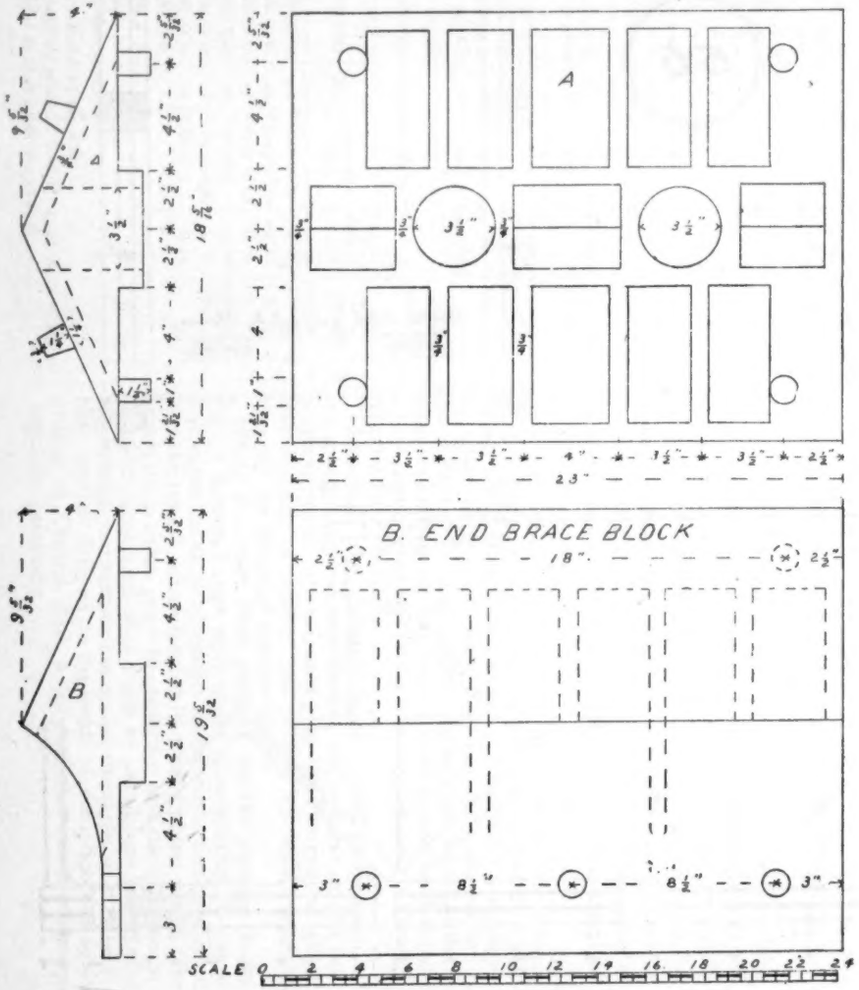


PLATE 117.


H, WASHER FOR 1¼"-1⅜" RODS
H₂ FOR 1½ RODS
H₂
H₁
G. WASHER FOR ⅞" RODS


I. PACKING SPOOL FOR TRACK STRINGER.
I
J
J. PACKING SPOOL FOR END BRACES.


E. STRAP TOP AND BOTTOM CHORD
E.
F. OUTSIDE CLAMP
F


A
A. BRACE. BLOCK TOP AND BOTTOM CHORD
B
B. END BRACE BLOCK
SCALE 0 2 4 6 8 10 12 14 16 18 20 22 24 IN.

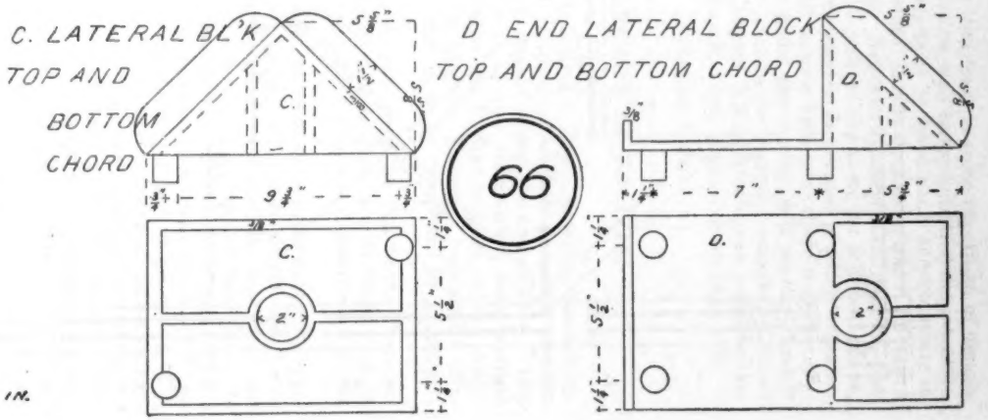
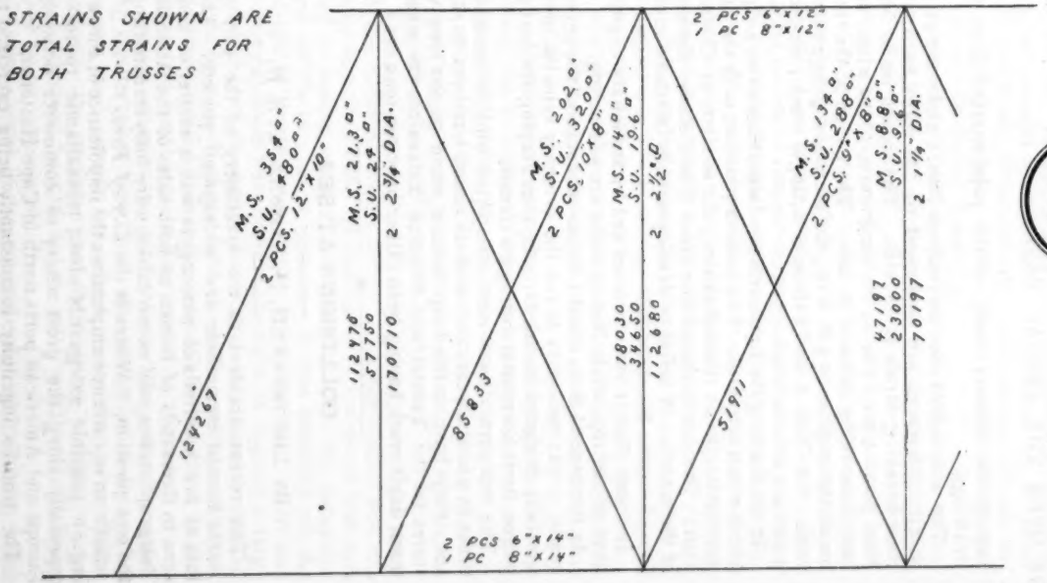
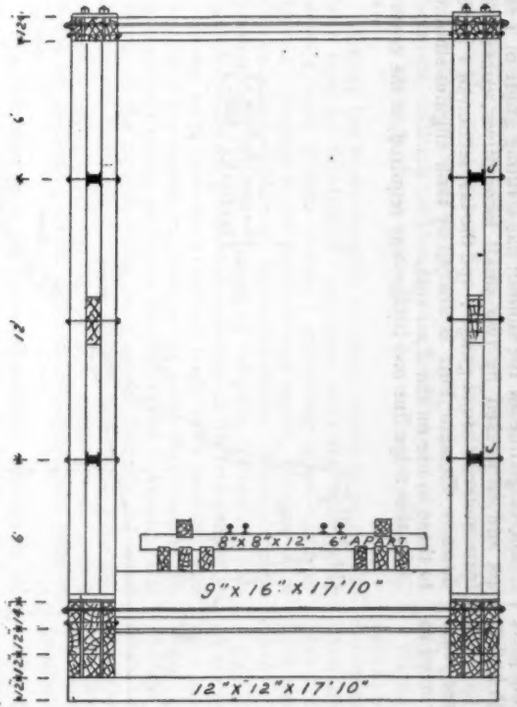

C. LATERAL BL'K TOP AND BOTTOM CHORD
C.
D END LATERAL BLOCK TOP AND BOTTOM CHORD
D.

PLATE 118

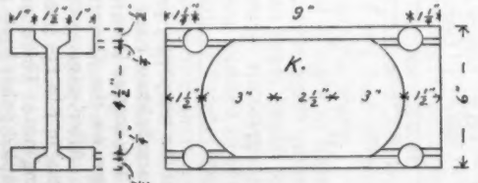


66

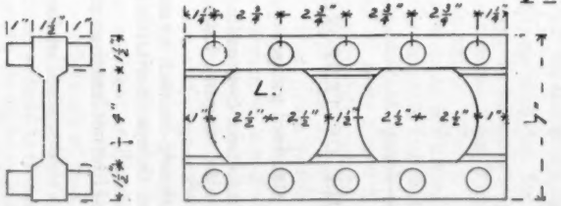


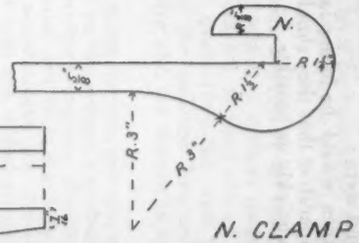
N. CLAMP BAR HEAD

K PACKING BLOCK TOP CHORD



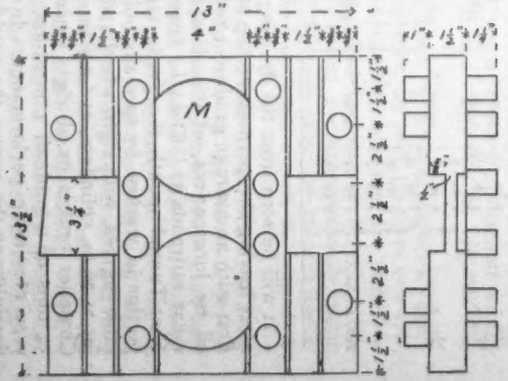
L. PACKING BLOCK BOTTOM CHORD

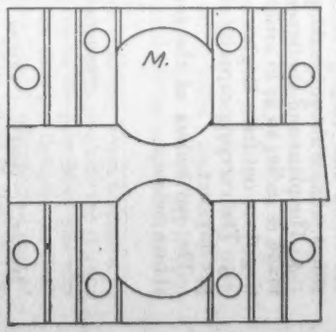




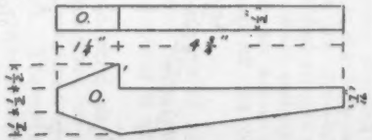
N. CLAMP BAR

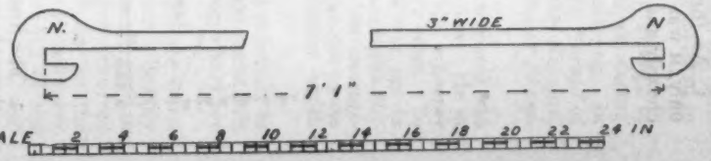
M. CLAMP HEAD





O. CLAMP KEY





SCALE 2 4 6 8 10 12 14 16 18 20 22 24 IN

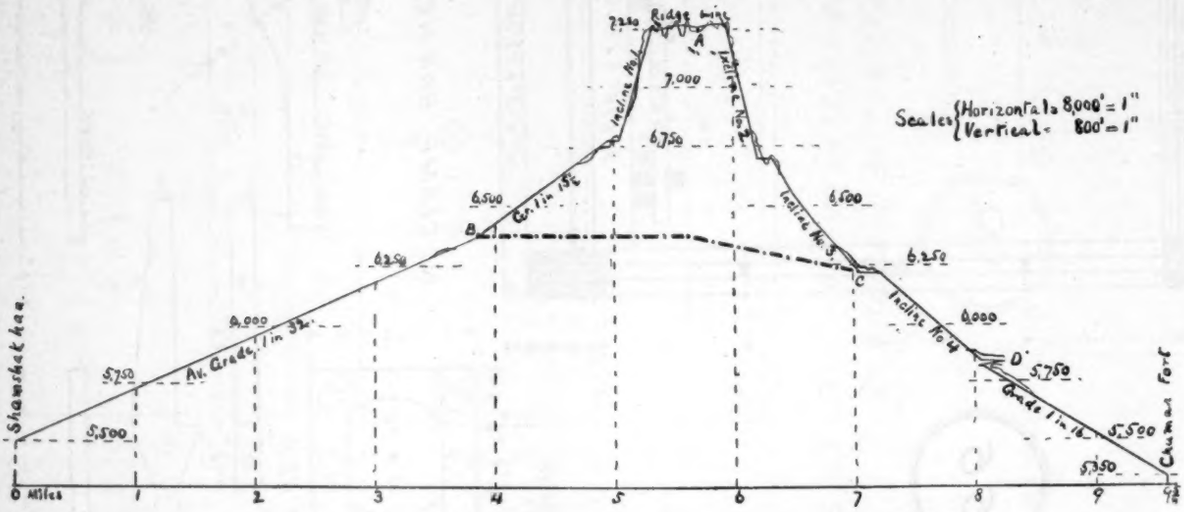
Accordingly a careful survey was made with the object of ascertaining the feasibility of making a temporary railroad to be rapidly and cheaply constructed, pending the completion of the tunnel, and the line shown in the plate was the one finally decided on. The points which had to be borne in mind were :

1. As the lines would be in use for two or three years only, it was imperative that they should be constructed as cheaply and as quickly as possible.

ed together with ball and socket joints, and the leading and trailing axle boxes have $\frac{1}{8}$ in. play in the pedestals in each direction, or $1\frac{1}{4}$ in. altogether.

The ridge line on the summit has a ruling grade of 1 in 40, and is worked by two small locomotives, converted from meter to broad gauge ; and the last section of 1 in 16 down to Chaman Fort is worked by tank engines similar to those in use on the East side.

On this ridge line one bridge was required, at the cross-



PROFILE OF TEMPORARY LINE OVER THE KHOJAK PASS.

2. The lines should be of the standard gauge—5 ft. 6 in. —throughout.

3. The inclines should be able to take over ordinary locomotives and rolling stock ; also wagons loaded with stores, etc., without breaking bulk.

4. The plant and appliances should be such as could be made in India, so as to avoid the delays inevitable in getting them out from England.

5. The carrying capacity should be not less than 400 tons per day, net.

The particulars of the four cable worked inclines are shown below :

DETAILS OF INCLINES.

INCLINE.	GRADE.	LENGTH.	VERTICAL HEIGHT.	MAXIMUM TRAIN-LOAD.	WORKING STRAIN OF CABLE.
No. 1.	1 in 2¾	1,320 ft.	452 ft.	30 tons.	12 tons.
No. 2.....	1 in 2½	1,420 "	568 "	30 "	13 "
No. 3.....	1 in 7 1 in 8 1 in 9 1 in 10	3,950 "	484 "	40 "	2½ "
No. 4.....	1 in 8 1 in 12 1 in 13	4,700 "	376 "	50 "	4 "

It will be seen from the drawing that the temporary line after leaving the permanent line at Shamshakhan rises at first with an average grade of 1 in 22 ; this section is worked by locomotives, of the class known on the Government railroads as " Class L, heavy." After passing the East Tunnel mouth the grade steepens to 1 in 15½ ; this portion is worked by specially built engines. These are tank engines, with eight wheels, all coupled ; they have 18 in. × 26 in. cylinders, and are fitted with hand, steam and Chatelier brakes on all eight wheels ; they take a load of 54 tons up a grade of 1 in 15 and round 500 ft. curves—a very creditable performance. In order to increase their flexibility on the curves, the outside coupling rods are join-

ing of the military road, at the point marked *A* on the drawing.

The wire cables used on inclines Nos. 1 and 2 are 4½ in. in circumference, are composed of 114 wires each, and their breaking strain is 78 tons. The cables on inclines Nos. 3 and 4 are 2⅝ in. in circumference, of 72 wires, and have a breaking strain of 30 tons. The gauge of the track on all the inclines is 5 ft. 6 in., the standard gauge of the road. On Nos. 1 and 2 there is a single track ; on Nos. 3 and 4 a double track.

In the drawing the figures on the dotted lines show height above mean sea level. The eastern junction with the permanent line is at Shamshakhan ; the western at Chaman Fort. The heavy dotted line from *B* to *C* shows the level of the tunnel. A spiral or development is indicated at the foot of incline No. 4, at *D*.

Inclines Nos. 1 and 2 are worked by stationary engines fixed on the top, while Nos. 3 and 4 are self-acting.

In the case of Nos. 1 and 2, in consequence of the severe grade, it was necessary to run the ordinary vehicles on to specially designed inclined trucks, thus keeping the loaded wagon itself horizontal during its transit.

The temporary lines were completed and in working order in about a year, and cost in round numbers $178,-500 ; they have carried up to date some 50,000 tons of stores for the Tunnel and Chaman Extension, the maximum day's work having been rather over 500 tons net.

COLLISIONS AT SEA.

BY LIEUTENANT H. H. BARROLL, U. S. N.

THE recent accident to the machinery of the *City of Paris* caused immediate and widespread anxiety. The fate of her hundreds of passengers was a matter of concern to thousands of homes on both sides of the Atlantic. Telegraph wires and ocean cables were busy transmitting the one question, " Where is the *City of Paris ?*"

Such an occurrence emphasizes the importance of throwing all possible safeguards about transatlantic routes—especially along the great artery of commerce between Europe and American ports north of Cape Hatteras.

The world's ingenuity is constantly being exercised to

give to ocean travel the greatest security; and the modern large ocean steamer, as at present constructed, is as near perfection as the human mind can devise. From the original design, consisting of one or at most two compartments, generally with communicating passage-ways, the steamship of the present day is built with half a dozen separate transverse and longitudinal compartments, cellular bottoms, collision bulkheads, etc., while electric lights and steam steering gear greatly diminish the chances of collision.

Among the many dangers to which ocean travel is subject may be mentioned: collisions with ice, with other vessels, with sunken wrecks; grounding upon rocks or shoals; damage to the machinery or spars; dangers from fire or boiler explosions; mutinous crews; intemperate or incompetent officials. But of all dangers, *collision* is that which causes the greatest destruction of life and property.

Many ways have been devised, many laws enacted, and yet not a day passes but brings the news that, despite the precautions taken, accidents have occurred. Admiral Colomb, of the British Navy, in a speech recently delivered before the British Institute of Naval Architects, gave statistics showing that from three to five vessels are sunk each week by collision; while the number sometimes rises to seven.

The intemperance or incompetence of officials is no doubt responsible for many collisions; but this can in a great measure be guarded against by rigid examinations, and allowing promotion to follow only after a thorough exhibition of those qualities which go to make the capable seaman. There always remains the doubt, even after the most searching examination, as to whether the official has the habit of conducting himself properly when not under examination; and therefore a system which puts him under a certain amount of surveillance at all times will be found to be beneficial. The perfectly correct officer will not object to this surveillance, while the incorrect or incompetent one should be forced to stand it.

This system of careful examination is followed to the utmost extent in the promotion of officers serving aboard transatlantic steamers. They are required to serve a thorough apprenticeship in the lower grades, and in no other calling or service can nepotism or favoritism be said to have so little influence in determining promotion.

But there are dangers which still exist, despite the most careful system of inspection, and notwithstanding the most rigid examinations for competence. Shearing rivets, flaws in castings, cyclonic storms and dense fog banks will still cause trouble to the most experienced commanders, and endanger the most thoroughly constructed vessels. There is always a certain amount of danger to be encountered in threading one's way among thousands of other vessels, whose condition may not be so satisfactorily determined. It becomes as dangerous to meet a vessel in the hands of an ignorant officer as to sail under an incompetent commander.

To other trouble is added, so far as steamers are concerned, the necessity of avoiding the thousands of sailing vessels which throng the track between Europe and America, secure in the hard-and-fast rule which requires all steamers to keep out of the way of all sailing vessels, no matter what the circumstances of the case.

This pernicious "Rule Twenty" is responsible for many of the collsions which occur. The regulation was enacted at a time when the commerce of the world was carried in sailing vessels, and steamers were the exception and not the rule, as at present. It was evidently not the design of the framers of that regulation that small and handy cat-boats were to have the right to require a large 500-ft. vessel to change her course in a narrow channel, when by a touch of the helm the sailing vessel could steer clear and avoid all danger; yet such is the effect of this regulation, as at present interpreted.

On one occasion the great steamer *Oregon*, when entering the harbor of New York, was compelled to change her course, and almost run ashore upon the Jersey Flats, owing to the persistence of three young "toughs," who, in a Whitehall boat, defied the pilot to collide with them, they being "under sail."

There should be some modification of this rule, which requires steamships at all times to keep clear of sailing vessels. It may be argued that the commanders of steamers would themselves prefer that sailing vessels should "keep their course," and allow the steamship to do all of the manœuvering necessary to avoid a collision. If so, well and good; but let it be understood then that the sailing vessel *shall keep her course*, or else be considered in fault.

Numerous collisions are the direct result of change of course by sailing vessels at a critical moment, rendering it impossible for steamers to keep out of their way. In illustration of this, I quote from the New York *Herald* of May 6, in regard to the collision between the National Line steamer *Helvetia* and the American schooner *Bramhall*.

Captain Cochrane, of the *Helvetia*, said that the schooner was on the port tack, and on the steamer's starboard bow. He at once stopped the steamer's engines, thinking the schooner would keep her course, and cross the *Helvetia's* bows. To Captain Cochrane's astonishment, the *Bramhall* was put in stays, and a moment later she drifted directly across the *Helvetia's* bows. The *Helvetia* had almost entirely lost steerage-way, and this made it impossible for her to get out of the schooner's way. It was the shock of the collision which knocked out the schooner's masts.

There is no occasion for the captain of the schooner to explain why he found it imperative to go into stays at this particular time—Rule Twenty renders it unnecessary for him to do this.

The grotesque feature of the occurrence appears when we realize that this collision takes place between a heavily laden steamer of about 4,500 tons and a small 135-ton schooner of some 5 or 6 ft. draft. The collision occurred off Tompkinsville, where the channel available for the steamer is at most 2,000 yards, and that for the schooner is more than 5,000 yards in width. The length of the steamer is 420 ft. and that of the schooner is 95 ft., and yet the captain of the *Helvetia* finds it necessary to attempt to excuse himself for "not getting out of the way of the schooner," which tacked under his bows.

The law with regard to the carrying of running lights requires that all sea-going vessels, when under way, shall carry, between sunset and sunrise, a red light on the port and a green light on the starboard side, these to be of such intensity as to admit of their being seen on a clear dark night to a distance of two nautical miles; and they are to be so placed as to show an unbroken arc of light from right ahead around to two points abaft the beam of that side upon which the light is placed.

The regulations also require that the boxes intended to contain the lights shall be so placed as to preclude the chance of the starboard light showing upon the port bow, and vice versa; and to that end, ordain that the light-boxes shall be fitted with an inner screening board, which shall extend at least three feet in front of the light, so as to prohibit its rays from showing across the bows.

The law supposes that the boxes shall be placed in a line parallel with the keel as regards the longitudinal plane, and in a line parallel with the water-line as regards the horizontal plane.

If at night an observer from right ahead sights a vessel with her lights properly placed, he will then see two colored lights, which will indicate to him that the vessel is directly approaching him. But in event of the observer being situated in any other than the infinitesimally small angle of "right ahead," he sees only one colored speck from which to judge the line upon which the vessel is steering.

In the case of a steamer, the law requires that she shall not only keep out of the way of a sailing vessel under all circumstances, but in order that she may publish the fact of her nature, the steamer is required to carry, in addition to the colored side-lights, a white mast-head light which shall show to a distance of at least five miles, and which indicates to the sailing ship that she is authorized to crowd, to the utmost, the unfortunate steamer. Therefore, the white mast-head light, while enabling the sailing vessel to determine with more exactness the steamer's course, becomes, so far as sailing vessels are concerned, an additional element of danger to the steamer's commander.

Notwithstanding the simplicity of the lights required by law, and the meagerness of the information which these guides furnish, there are hundreds of vessels now sailing the seas which disregard the law, or barely keep within the letter of the law, and thus save a few gallons of oil or the few moments of time it would require each day to put the lights in their boxes. Vessels are often only provided with the cheapest and least efficient means of complying with the law. They apparently only seek to be supplied with the material for evading the penalties of collision, rather than the means of avoiding collisions. Vessel owners, from a mistaken idea of economy, furnish their vessels with inferior lights, while the commanders will take advantage of all excuses to save the trouble and expense of keeping even these poor lights in proper position. Moderately light nights, long twilights and moonlight nights serve as excuses to delay, or even to omit placing these simple aids where they may be seen.

Simple deck lanterns, covered with green or red bunting, are made to do duty as red and green side-lights, and cases have been cited where plain white lanterns have been given a thin coating of green or red paint to cause them to emit the colored rays. All of this is manifestly illegal and also criminal, since it may lead to the loss of life or property. These attempts diminish the distance of visibility of the lights, and are in direct violation of the requirements of Rule 3 of Section 4,233 of the Revised Statutes, which provides that all colored running lights shall be of such intensity as to be visible at the distance of two nautical miles. No reduction in this distance should be allowed.

This is a very short time to allow the officer in charge of a swift steamer in which to decide how he is to clear the vessel, whose faint speck of a light he has just discerned. A steamer such as the *Etruria* or *City of Paris*, traveling at the rate of 20 knots an hour, will traverse a distance of 2,000 ft. in one minute, or a mile in three minutes. Two such steamers will approach each other, on opposite courses, at the rate of 46 miles an hour—the average rate of express trains. If it is considered necessary to carry the lights at all, it should be considered necessary to have them show to a distance of at least two nautical miles. Of course this is plenty of time in which to avoid a collision, provided that we know the exact course upon which the rival steamer is coming; but routes by sea are not as absolutely defined as are railroad tracks on shore, and it is therefore necessary to have some time in which to judge by change of bearing this line upon which she is steering.

Any person who has been to sea in an official capacity for any length of time will testify that he has, time and again, especially upon our own coasts, encountered vessels at night without the slightest sign of a light visible—also that not one-half of the side-lights carried by the ordinary small vessel are visible to the distance of two nautical miles. I am not far wrong in asserting that there are now hundreds of small vessels whose side-lights are not visible, under the most favorable circumstances, at a distance of one nautical mile.

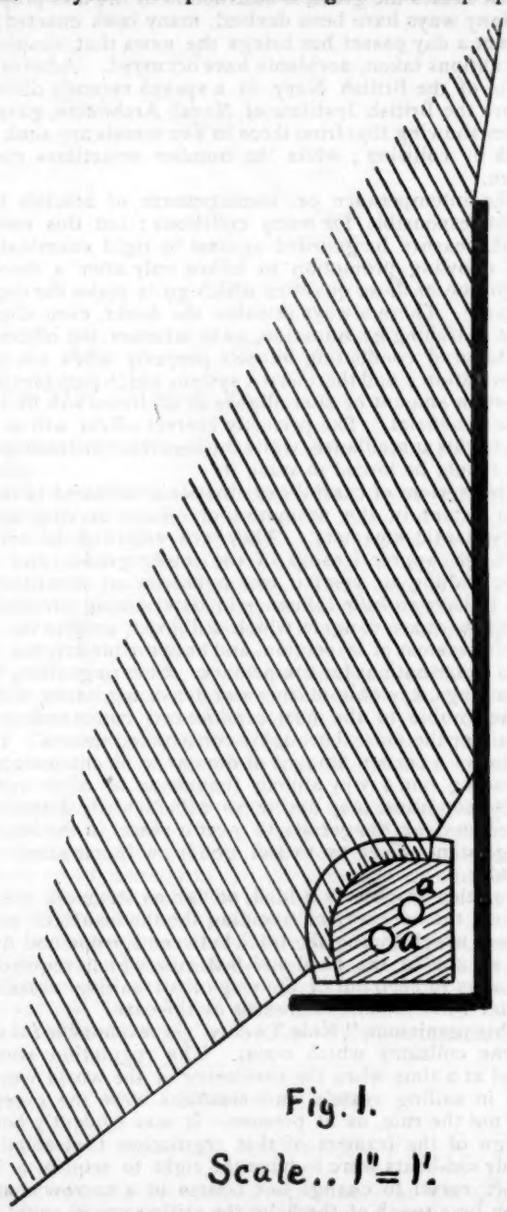
At the recent Maritime Conference in Washington, it was announced by one of the Austrian delegates that 90 per cent. of the light was lost by its transmission through colored glass; and a Report recently made by a committee in Germany showed that red lenses absorbed 60 to 80 per cent. of the light's intensity, and green lenses absorbed 90 per cent.

When we take into consideration the effect of fogs and hazy weather in the reduction of this distance of visibility, and the manner in which vessels are crowded together, as their several courses converge at the entrances to such great ports as New York or Liverpool, it becomes a matter of surprise that collisions so seldom occur.

It is but justice to say that the great majority of the seagoing vessels which neglect to carry the required running lights are shown to be sailing vessels—principally the smaller craft. The very nature of the Rule which gives to these craft a practical monopoly of the ocean's surface, when contested by a steamer, causes them in many cases to disregard the proper precautions; and they are content to exhibit the running lights at the final moment, yet early enough under the law to clear themselves of the charge of not having had their lights burning. It is a common custom with some sailing vessels to put the running lights in the boxes only, when at night another vessel's lights have been sighted.

Not infrequently we will meet vessels carrying their side-lights simply lashed to the rigging, and therefore following the sheer of the vessel's bows. The screen extends in mockery three feet beyond the light, and the captain, in fancied security, is allowed to sail forth, causing more damage to maritime commerce than if he carried no lights at all.

Too much stress cannot be laid upon the importance of having the light-boxes properly placed. It will generally be found that the error in this position consists in thus permitting them to follow the sheer of the vessel's bow, thereby allowing their rays to intersect at some point ahead. Beyond this point both lights will improperly show across the bows. This point is the apex of an angle, which may be termed the "Angle of Error," since all observers situated within this angle are liable to be in error as to the course upon which an approaching vessel is steering.



The distance of this point of intersection from the vessel's lights will of course depend directly upon the amount of error in the position of her lights, as well as upon the breadth of beam of the vessel carrying the lights.

If the light-boxes were placed so as to allow the colored lights to show only directly ahead, as the law requires, then theoretically there would be a belt extending ahead, and equal in width to the beam of the vessel, inside of which space neither the red nor the green light would be seen. The only point where the two lights could possibly be seen at the same instant would be at the vanishing point of these two parallels, drawn along the starboard and port sides of the vessel.

But in practice we know that this is not the case, and that at a comparatively short distance ahead of the vessel her two colored lights can be seen simultaneously. This is due to the fact that the lanterns themselves are not in line with the fore-and-aft screens. Although the light-screens may be placed in the exact fore-and-aft line, the rays proceeding from the outer parts of the lenses will still cause the light to be seen across the bow.

Commander F. E. Chadwick, U. S. N., commanding the U. S. Steamer *Yorktown*, in a report concerning the recent trial of range-light systems, calls attention to this fact in the following words:

> It will be observed that there are large discrepancies between the estimates of observers and the actual bearings in some of the double-light observations. This arose largely from the fact that the lights show over greater angles than intended. I have had a trial made of the arc of illumination of the side-lights of this ship, and find that the light itself will show, actually, as far aft as three points on the quarter (the reflection of the light on the sides of the light-box—the lights are electric, and very brilliant—showing considerably further aft), and across the bow one and three-quarter points.
>
> I think very few if any of the lights used are accurate in regard to the illuminated arc. Every portion of the flame throws a ray, and tangents drawn from its circumference to the edges of the light-box mark properly the limits of illumination.

Fig. 1 represents the light and light-box of this vessel on a scale of 1 in. to the foot. This shows the angle over which the *Yorktown's* lights must necessarily show, although they actually show much further—both across the bows and abaft the beam.

In the other diagrams the lines have been drawn at arbitrary angles, but will suffice to illustrate the effect of additional error in the placing of the side-lights. It is evident that, from the causes mentioned by Commander Chadwick, there will be a constant error, even when the light-screens are placed in an exact fore-and-aft line. This, for the ordinary lantern, will be an error of about 8°.

In fig. 2, in the small triangle $X\,Y\,Z$, representing the light and the light-box of a vessel, suppose $X\,Y$ to represent 6 in. (which would probably be the width of the smallest lantern carried) and $Y\,Z$ to represent the screening board, which is to extend 3 ft. beyond the light; the tangent of the angle at Z would be 6 in. divided by (36 + 6) 42 in., or,

$$Z = 8°\ 8'.$$

This, then, will necessarily cause lights to show across the bows of a vessel of 15 ft. beam, at a distance of about 50 feet, and a vessel of 30 ft. beam, at a distance of about 100 ft. in front of the vessel's lights.

To demonstrate the effect of additional error in the placing of the light-boxes, let $A\,B$ (fig. 3) represent the half-

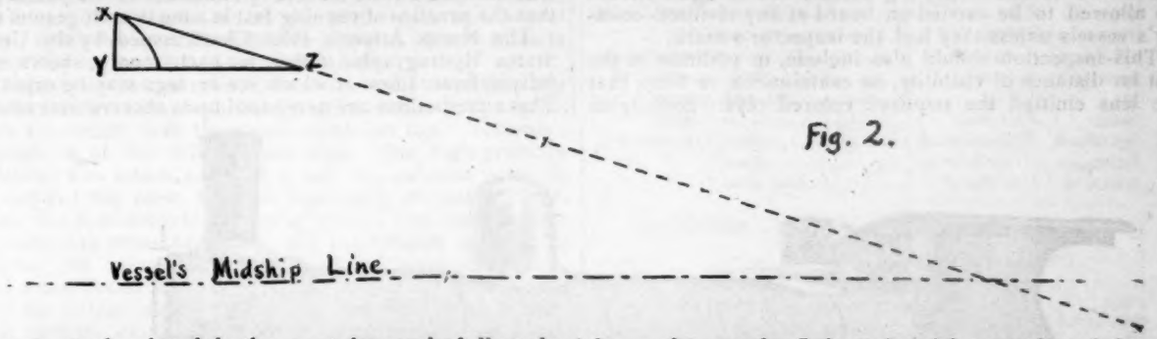


Fig. 2.

beam of a vessel, C the point of intersection of the rays with the midship line, after leaving the properly placed screening-board, and C the point of intersection due to additional error. The secant $B\,C'$ cutting the two parallels, $B\,O$ and $A\,C'$, the angle at C' represents the total deviation from a direct line ahead; or the constant angle (8°) at C, plus the additional angular error of the light screens from a fore-and-aft line.

In the triangle $A\,B\,C'$,

$$\text{tangent } C' = A\,B \div A\,C'$$
$$A\,C' = A\,B \times \text{cotangent } C'.$$

By this it will be seen that an additional error of one point (11¼°) will cause the rays from the outer part of the lens to intersect the midship line of a vessel of 15 ft. beam, at a distance of only 21.3 ft., and with a vessel of 30 ft. beam, at a distance of only 42.6 ft., ahead of the the screening boards.

There is, then, beyond this point, a constantly widening angle, in which an observer is liable to be deceived, supposing that by seeing two lights at once he can estimate within the customary ¼ of a point the course upon which the vessel is approaching.

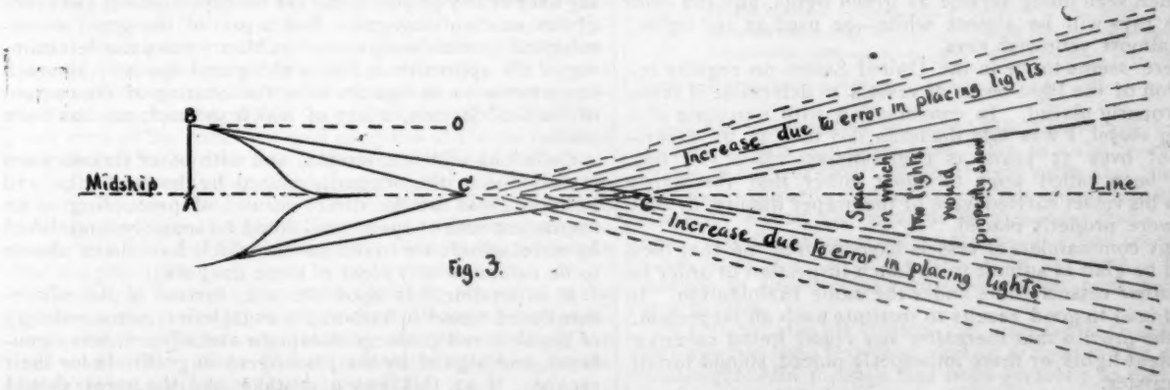


Fig. 3.

The foregoing are the principal sources from which collisions arise; and the only way to prevent their occurrence is to endeavor, by close inspections and heavy penalties, to obtain strict observance of the existing laws. The Washington Maritime Conference has made a step in the right direction in discussing the several excellent systems of range-lights, and in calling attention to the loss of light by transmission through colored lenses; but the greatest improvement that could be made would be in the strict enforcement of the present rules regarding the placing and

carrying of the lights now demanded by the law. Until we can be sure that the present simple and cheap requirements are provided according to existing law, it is sheer waste of time to formulate new regulations or prescribe additional lights, fog-whistles, etc.

Lights should show to some definite distance, and to insure this there should be some official inspection of the lights themselves, some testing examination of the running lights, before they are allowed to be sold. Such examinations are made by Government officials for steam-boilers, steam gauges, etc., and why should not the same care be taken with the means for avoiding collisions?

All lights should be clearly stamped with the name or the initials of this inspecting officer, and no lights should be allowed to be carried on board of any civilized country's vessels unless they had the inspector's mark.

This inspection should also include, in addition to the test for distance of visibility, an examination to show that the lens emitted the required colored rays. Side-lights are often seen doing service as green lights, and the color of the rays will be almost white—or used as red lights, with almost yellowish rays.

There seems to be in the United States no regular inspection of the light-boxes of vessels to determine if these are properly placed. In conversation with a captain of a sailing vessel, I was told the other day that, in an experience of over 35 years as commanding officer, he had never been called upon to show either that the lights which his vessel carried were of the proper quality, or that they were properly placed.

Many commanders of vessels have assured me that they would be glad to submit to any such inspection in order to have other vessels come under the same examination. It would lead to good results to institute such an inspection, with the proviso that thereafter any vessel found carrying inefficient lights, or these improperly placed, should forfeit her register.

It will be argued that this is impracticable--that it imposes additional expenses upon small vessels, which already have to pay heavy running expenses. The only answer to this is, that any vessel that is too small to warrant her carrying the necessary and reasonable means required by law for her safety and that of other vessels at night, should not be allowed to be abroad during that time.

Even supposing that she is the only sufferer by the collision, the fact yet remains that in most cases any officer will endanger his own vessel's safety, in hope of avoiding a collision, rather than deliberately run down another vessel, although the latter may be clearly in the wrong.

A great element of safety could be introduced into transatlantic travel if the passengers could be made to clearly understand the great risks that they are required to undergo when the officials disregard the requirements of the law.

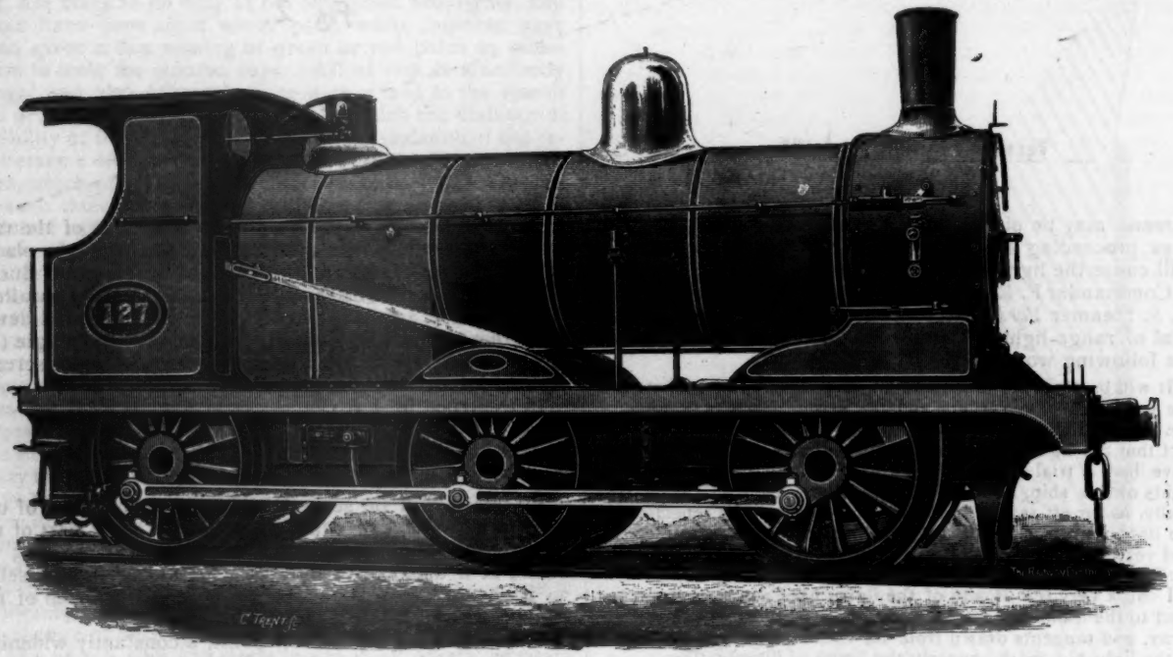
Transatlantic travel has now become so common that even the layman is to a certain extent aware of the principal dangers to be apprehended; and although the captain, from his citadel of reserve, may parry the questions of the anxious passenger, yet there are times when such danger makes itself too painfully apparent.

When, some years ago, a large steamship ran at the rate of 10 knots, full tilt, into an enormous iceberg—a solid island of ice—and tore off about 15 ft. of her bows, there was no need for the officers to announce to the passengers that the practice of running fast in a fog is a dangerous one.

The North Atlantic Pilot Chart, issued by the United States Hydrographic Office for each month, shows carefully defined lines at which ice or fogs may be expected. These predictions are now based upon observations extending over nearly 50 years, and are the experience of hundreds of thousands of voyages. It is a part of the great meteorological system inaugurated by Maury; and the determining of the approximate limits of fog and ice is of as much importance to navigators as is the locating of the current of the Gulf Stream, a fact of which so much use has been made.

Collisions with ice, wrecks, and with other steamers are mainly due to the obscurity caused by the fog banks, and in many cases are the direct results of proceeding at an imprudent rate of speed, and could be sensibly diminished by strict adherence to the routes which have been shown to lie comparatively clear of these dangers.

It is possible that upon the safe arrival of the above-mentioned vessel in harbor, the usual letter, commendatory of the skill and coolness of captain and officers, was circulated, and signed by the passengers in gratitude for their escape. If so, this was a mistake, and the paper should have been sent instead to the careful ship-builders on the Clyde, whose honest riveting, close inspection, and attention to detail rendered the tight-fitting bulkheads capable of counteracting the consequences of the captain's mistake.



COMPOUND FREIGHT LOCOMOTIVE, GREAT EASTERN RAILWAY, ENGLAND.

AN ENGLISH COMPOUND FREIGHT LOCOMOTIVE.

THE accompanying illustration, from the *Railway Engineer*, shows a six-wheel connected compound locomotive, of the Worsdell-Von Borries type, built for freight service

on the Great Eastern Railway, at the shops of that company in Stratford, England, and from the plans of Mr. James Holden, Locomotive Superintendent of the road.

The boiler is 52 in. diameter of barrel; the fire-box is 63¾ in. long by 40½ in. wide inside, the depth being 67⅞ in. in front and 61½ in. at the back. There are 252 tubes, 1⅝ in. outside diameter and 10 ft. 4 in. long. The area of the grate is 17.9 sq. ft.; the heating surface is: Fire-box, 105 sq. ft.; tubes, 1,109 sq. ft.; total, 1,214 sq. ft. The usual working pressure is 175 lbs. The boiler shell is of steel; the tubes are of steel, and the fire-box of copper.

The wheels are 58 in. in diameter; the bearings are 7½ in. in diameter and 9 in. long. The crank-axle has the journals for the connecting rod 8 in. in diameter and 4½ in. long. The frames are of the plate type, and are of steel, 1½ in. thick. The distances between centers of axles are 7 ft. 7 in. and 8 ft. 6 in. respectively.

The high-pressure cylinder is 18 in. in diameter and the low pressure 26 in., both being 24 in. stroke. The cylinders are inside, with the steam-chests on top. The valve motion is of the shifting link type. The high-pressure cylinder has steam ports 1¾ × 12¾ in., exhaust ports 3½ × 12¾ in.; the valve has ¾ in. lap and ¼ in. inside clearance, the maximum travel being 3⅞ in. The low-pressure cylinder has steam ports 2 × 16½ in., exhaust ports 3½ × 16½ in.; the valve has ⅞ in. lap, $\frac{5}{16}$ in. inside clearance, and a maximum travel of 3⅞ in. The valves are of bronze and the pistons of wrought iron. The engine has a variable exhaust, controlled from the foot-board.

The boiler, it will be seen, is of the straight-top pattern. The center of the boiler is 7 ft. 6 in. above the rails. The total height from rail to top of smoke-stack is 12 ft. 11 in. The total length of the engine is 24 ft. 10 in.

The total weight of this locomotive in working order is 88,300 lbs., of which 33,300 lbs. are carried on the forward pair of wheels, 30 600 lbs. on the main driving wheels, and 24,400 lbs. on the rear or trailing wheels.

THE RAILROADS OF THE UNITED STATES.

THE publishers of *Poor's Manual of the Railroads of the United States* have for some years past issued a carefully prepared summary of the general railroad operations of the year, made up from the figures furnished for the *Manual*. This summary has the disadvantages that it is made up from statistics covering varying fiscal years and varying forms of report, and that the figures are not officially required, but furnished voluntarily by the companies. On the other hand, it is at present the only source attainable for a general review of the railroads; the figures are probably correct as furnished, and are carefully analyzed and compared, so that they give an approximately correct view of the condition and progress of the railroads of the United States which is both interesting and valuable.

In the accompanying table are given, for 1889, the main results as expressed in the Introduction to the *Manual*, with a few slight changes in form only. The comparisons made are with the figures obtained from the same source for the year 1888.

Passenger business furnished about 27 per cent. of the gross earnings, freight 66.4 per cent., miscellaneous earnings—mail, express, etc.—making up the remaining 6.6 per cent. The proportion of passenger business to the total shows a slight increase over 1888.

The interest and dividends paid amounted to about 3 per cent. on the total stock and debt; but the dividends alone were only 1.77 per cent. on the total amount of stock. Of course a large part of the stock received no dividend whatever.

Taking the population on the basis of the Census of 1880, the United States has now one mile of railroad to 18.75 square miles of territory, or to 404 inhabitants; the last figure is probably too small, as the increase in population since 1880 has been considerable.

The *Manual* calls attention again to the steady decrease in rates. In eight years the passenger mileage of the railroads has increased 71 per cent., but the average rate per passenger-mile has fallen from 2.514 to 2.170 cents, a decrease of 13¾ per cent. With freight rates this has been still more marked; the increase in ton-miles in eight years has been almost the same as in passenger traffic, 72 per cent., but the average rate per ton-mile has fallen from 1.236 cents to 0.976 cent, a loss of 21 per cent. The reduction in expenses has, however, about kept pace with that in rates.

It is to be noted that while the increase in freight-train mileage has been less than that in freight traffic, that in passenger-train mileage has been greater; so that, while the average freight-train load increases every year, the average passenger-train load is actually less than it was eight years ago.

The results of the year in a general way were good, the figures showing a heathy gain in traffic, with a reduction in working expenses and a consequent increase in traffic. One result of this has been the expenditure of large sums in improvements, as shown in the increases in the number of locomotives and cars and in the increase in mileage of track laid with steel, replacing the old iron rails, which are now gradually but steadily disappearing from the tracks, and in a few years will be entirely gone.

RAILROADS OF THE UNITED STATES IN 1889.

	1889.	Increase or Decrease.		Per cent. of Change.
1. *Property:*				
Total mileage of roads	160,544	I.	6,268	4.1
Additional tracks and sidings	42,242	I.	5,021	13.3
Total miles track	202,786	I.	11,289	5.9
Miles laid with steel rails	151,723	I.	13,207	9.6
" " " iron "	51,063	D.	1,918	3.6
No. of locomotives	31,062	I.	1,664	5.7
" passenger cars	23,465	I.	2,040	9 5
" baggage, mail, etc	7,184	I.	357	5-3
" freight cars	1,060 164	I.	55,048	5-5
Total amount of stock	$4,495,099,318	I.	$92,687,976	2.1
" " " bonds	4,828,365,771	I.	204,330,748	4-4
" " " other debts	607,988,057	I.	62 947,113	11.5
Total liabilities	$9 931,453,146	I.	$359 965,837	3.8
Operations:				
Miles of road operated	152,689	I.	7,348	5.1
Total earnings	$1,081,661,004	I.	$46,141,116	4.4
Working expenses	674,731,517	I.	21,473,186	3.3
Net earnings	$406 929,487	I.	$24,667,930	6.5
Charges—interest etc.	296,870,104	I.	10,259 598	3 6
Profit	$110,059,383	I.	$ 4,408,332	15.1
Total amount of dividends	70,532,863	I.	589,822	0.7
Miles run by revenue trains	723,772,142	I.	35,020,771	5.1
Passengers carried, number	495.124,769	I.	43.771,113	9.7
Passenger-miles	11,965,726,015	I.	775,112 336	6.9
Tons freight carried	619.137,237	I.	28,279,884	4.8
Ton-miles	68,604,012,396	I.	3,181,006,408	4.9
Averages:				
Earnings per mile of road	$7,084	D.	$41	0.6
Net earnings per mile of road	2,665	I.	35	1.3
Per cent of expenses	62.38	D.	0.71	.....
Earnings per train mile	137.200 cts.	D.	0.800 ct	0.6
Expenses " " "	93.300 "	D.	1.500 "	1.6
Earnings per passenger-mile	2.170 "	D.	0.076 "	3.4
" " ton-mile	0.976 "	D.	0.001 "	0.1
Average passenger journey	24.17 miles.	D.	0.61 mile.	2.5
" freight haul	110.80 "	I.	0.08 "	0.1
" passenger-train load	42.12 pass.	I.	0.90 pass.	2.2
" freight-train load	156.05 tons.	D.	0.67 ton.	0.4

Fig. 1.

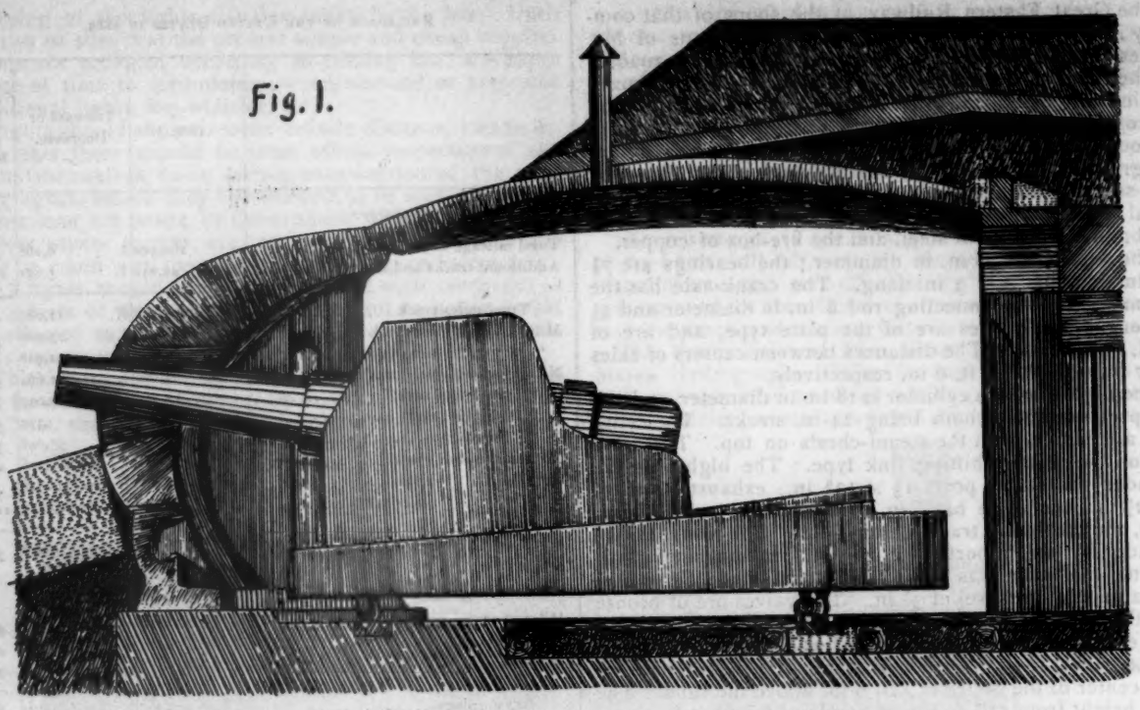


Fig. 2.

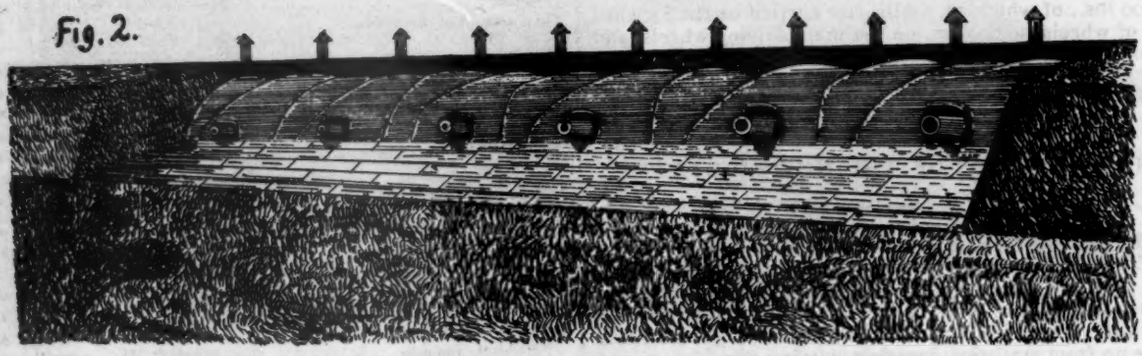
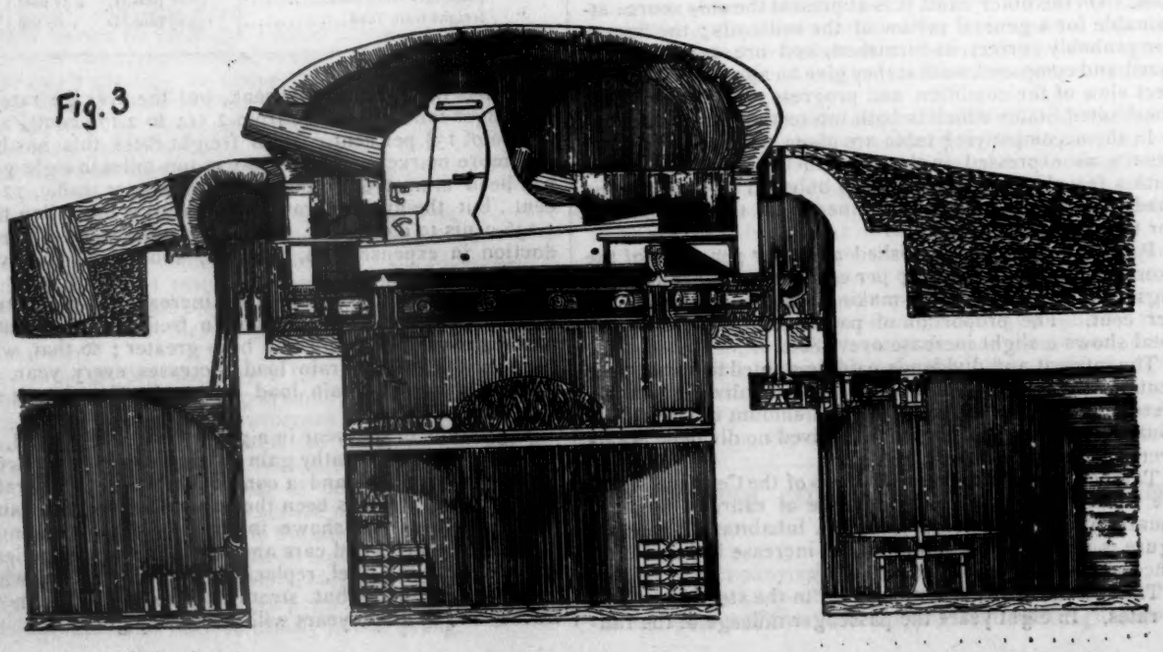


Fig. 3



THE DEVELOPMENT OF ARMOR.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

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(*Continued from page* 371.)

XV.—ARMOR AS APPLIED TO LAND DEFENSES.

One of the many lessons taught by the War of the Rebellion was that brick and granite were no match for rifled cannon. The experience of Fort Pulaski, in 1862, of Fort Sumter in the following year, confirmed at Strasburg during the Franco-German War, demonstrated beyond a doubt the vulnerability of masonry before rifled guns of very moderate power, and that the elaborate piles of stone and mortar which so long had defied all attack except the slow approach by pick and shovel, had become death-traps under the new conditions of warfare. The military engineer was perforce compelled to seek some other material with which to construct sea-coast and inland fortifications. The advance already made in the application of metal to ships of war furnished a solution to the problem.

The development of armor-plate, as applied to ships, has already been sufficiently discussed. The experience there gained was of great value when its employment upon land defense became a necessity. The form in which metal should be used—whether as wrought-iron, cast-iron or as steel; the character of the structures to which it should be applied, with many other details, are questions about which there is wide difference of opinion; only upon the single point that metal in some shape, either alone or in combination with other materials, must be employed, has there been unanimity of view. It is proposed to notice briefly the systems that already have been put in actual practice, or that have received the sanction of practical military engineers.

The ideal armor-plate is, no doubt, one that combines the virtues of the two distinct varieties of armor—hard and soft—that is, one that, while presenting a hard, rigid, unyielding surface to the impact of a shot, has behind it an elastic, tenacious interior that will hold the hard outer layers up to their work, at the same time localizing the effect of a blow, and preventing cracks and fissures from spreading from front to rear, as is the case in homogeneous metal. The elasticity of the backing also tends to distribute the effects of the blow from the point of application over the whole mass. Compound armor is the practical outcome of efforts to secure this end, and to-day all varieties of armor-plate—the all steel and the Grüson cast-iron, of which we are about to speak—aim to combine a hard face with a relatively soft and elastic back.

XVI.—GRÜSON'S CHILLED IRON ARMOR.

As early as 1868 Herr Grüson brought forward his chilled cast-iron armor, and since that date it has gradually grown in favor, and now occupies a very important position in the matter of material for permanent forts and fortifications. As has been previously stated, Grüson's cast-iron owes its success to the superior grade of iron employed, and the peculiar method of casting. In selecting his materials two kinds of pig-iron are chosen, each possessing one of the desired qualities—one a highly carbonized, hard white iron, the other a soft gray iron. In the casting, the object to be attained is "to combine the different materials together with such gradual changes of their respective properties that no marked line of separation should occur." The result is obtained by the use of iron moulds, which prevent, by a rapid cooling of the surface, the tendency in a fluid casting of the carbon to separate off in the form of scales of graphite. In examining the fracture of a Grüson casting there is no noticeable line of demarcation between the hard outer surface and the soft gray iron of the interior.

The Grüson chilled iron-armor is employed in two general classes of works—protected fixed batteries and revolving turrets; the questions of volume of fire to be obtained, of site and of available space deciding in each instance the character of the work to be constructed. Aside from the quality of metal employed, it is claimed for the Grüson system that the curved surface given to the plates adds enormously to their resisting powers; that by their peculiar form the plates support each other, and that their great weight renders bolting together unnecessary. Further, that by pivoting the gun carriages within the port, this aperture is reduced to but slightly greater dimensions than the chase of the gun, thus rendering port-shutters or screens unnecessary.

Fig. 1 shows in section a Grüson armored battery. The port or embrasure plates form the chief part of the armor. These are supported on either side by pillar plates, and rest upon pivot plates. Protection against curved fire is obtained by roof-plates, which in front join the port and pillar plates, and in rear rest upon pillars of masonry forming part of the casemate. Stability is secured by planing to a flat surface the adjoining edges of the several plates, and providing each edge with a corresponding groove into which melted zinc can be run or iron plugs inserted when the battery plates are put in place. The whole rests upon a solid masonry foundation. The ends of the battery rest against masonry covered with a parapet of earth. Immediately in front of the guns is a mass of concrete covered with granite blocks. The magazines are placed in the basement of the casemates, with which they communicate by means of stairways and lifts. Fig. 2 gives an exterior view of such a battery.

Where only a limited area of site is obtainable, or a large arc of horizontal fire is desired, revolving turrets, whose fire can be delivered through the whole 360° of arc, are resorted to. Fig. 3 gives a sectional view of a Grüson chilled iron turret, from which the general details of construction can be easily understood. The sides of a turret, or cupola, are almost identical in shape with the port-plates of an armored battery previously explained. The dome-shaped cover, or roof, is made up of a number of separate plates, and so constructed that their center of gravity passes through the middle point of the structure. They are held in place by their own weight. The whole rests upon a wrought-iron substructure, which in turn rotates on a live roller ring running on a roller path fixed to the foundation. This live roller way is without a central pivot, which allows the whole interior space to be utilized, it being possible to mount the guns through the central space from below. Transverse girders, fixed to the lower part of the iron substructure, support the guns and carriages. As in the battery, the adjoining edges of the roof and side plates are provided with grooves, and are secured in the same manner when the turret is set up. The base of the turret is protected, either wholly or in part, as may be required, by a glacis armor or ring of cast-iron plates. This is further protected by a layer of concrete covered with granite blocks.

The turret is rotated by pinion gear working in a circular rack, fixed to the upper roller-path. The gear may be worked either by a capstan hand-gear or by power. Twelve men are required to work the 12 in. gun, and can revolve the turret through the quarter of a circle in 4 minutes.

In the top of the turret is a man-hole, and sighting holes are provided for sighting the guns—a speaking-tube communicating with the man in charge of the steering gear. The magazines are in the basement. The cartridges are hoisted through a tube to the middle platform. The shell magazine is in the center chamber below the guns. The projectiles are raised by a lift to the platform under the cupola, from which a crane takes them to the breech of the gun.

The Spezzia turrets, for the four 119-ton Krupp guns, are constructed upon much the same model as represented in fig. 3, and are made up of 15 side and an equal number of glacis cast-iron plates, and have an interior diameter of about 33 ft. The turret for the 12-in. has of side and glacis plate, 11 each.

XVII.—EXPERIMENTS WITH CAST-IRON ARMOR.

The first experimental tests of Grüson cast-iron armor began in 1869, and continued until 1874. During this time

eight series of tests were had, with guns varying in caliber from 5.9 to 11 in., firing chilled iron projectiles against targets of from 11 in. to about 35½ in. in thickness. In no case were the plates perforated or materially injured. The projectiles uniformly broke up. At the close of the trials the adaptability of cast-iron used in heavy masses for purposes of defense was clearly established, and sufficient data had been obtained to determine the thickness of metal necessary to resist a given energy of impact of any gun or kind of projectile then in use.

From 1874 to 1882 no new experiments were had. But by the last date not only had the caliber of guns greatly and the striking energy of projectiles enormously increased, but with the latter, hardened steel had taken the place of the chilled iron formerly in use. To settle the questions raised by the improvements in guns and projectiles, a new series of experiments, 10 in number, were undertaken between 1882 and 1885. In these later experiments, guns of from 5.9 in. caliber to the 16.9-in. 100-ton Armstrong were pitted against glacis and turret-plates of from about 15 to 50 in. in thickness. Shot, weighted and empty shell of hardened steel were used. In no case were the targets breached except in a single case each of a turret and a glacis plate. A turret plate of 41.73 in. was breached in four rounds by a 12-in. Krupp rifle, firing empty shell of nearly 1,000 lbs. weight, and with a striking energy of over 14,000 foot-tons. In the other case, a glacis plate of 27.56 in. was breached by the same gun and under much the same conditions. In both of these instances the supporting masonry gave way, placing the target at great disadvantage.

The most interesting experiment was in 1886, when the 100-ton muzzle-loading Armstrong rifle, firing a Krupp steel shell weighted with lead and sand to 2,205 lbs., and having a striking energy of 47 481 foot-tons, was matched against a fac-simile of the Spezzia turrets, above referred to, the armor having a maximum radial thickness of 49 21 in. Fired at short range, not only this, but a St. Chamond steel shot of the same weight failed either to get through or to destroy the target. This record is the more important in view of the fact that two years before, at a competitive trial, upon the same ground, between a Cammel and a Brown compound, and a Schneider all-steel plate, each about 19 in. in thickness, the 100-ton B. L. gun had, at the first round, sent an 1,800 lbs. Krupp steel projectile through each of these plates, with a considerable surplus of energy in each case.

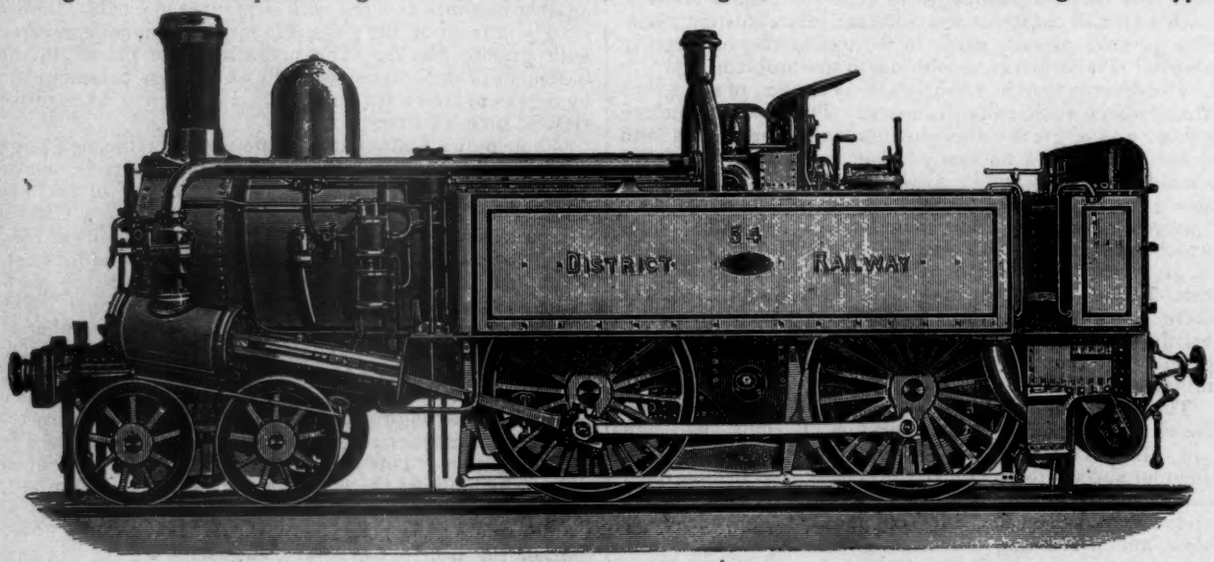
In connection with the experiments with cast-iron armor-plate, it is interesting to note the behavior of projectiles when brought in contact with this class of armor. Upon the target the effect was often nothing more than a bright splash or a slight indent the fraction of an inch in depth. In a few cases a depth of something over 2 in. was obtained. Upon the projectiles, shot and shell alike, the effect was uniform—they flew into pieces like glass; usually the head and point were showered in shapeless atoms, colored blue by heat, while the cylindrical part would be broken into many fragments. In the Spezzia experiments the heated fragments were hot enough to set fire to the timber balks behind the plates. Flat-headed shot were found more effective than pointed ones; empty shell did better work than those weighted with sand.

(TO BE CONTINUED.)

AN ENGLISH LOCOMOTIVE FOR LOCAL WORK.

THE accompanying illustration, from the London *Railway Press*, shows the latest locomotive for the Metropolitan District (underground) Railway in London. It is of the same general type as all the engines in use on that road, but includes the latest improvements made. The original type was designed for the underground service by Sir John Fowler, and the engine illustrated was built by Beyer, Peacock & Company in Manchester.

The engine, it will be seen, is of the eight-wheel type with four drivers coupled and a four-wheel truck, water being carried in two wing tanks, and coal in a bunker at the back of the foot-board. The boiler of this engine is 48 in. in diameter of barrel, and has 164 tubes 2 in. in diameter and 10 ft. 6⅜ in. in length. There are two tanks, each 15 ft. 6 in. in length and 3 ft. 6 in. in height, with a total capacity of 1,200 gals. of water. The coal bunker when full will hold about 3,000 lbs. of coal. The total heating surface is: Fire box, 90 sq. ft.; tubes, 903 sq. ft.; total, 993 sq. ft. The grate area is 15.7 sq. ft.



LOCOMOTIVE FOR THE METROPOLITAN DISTRICT RAILWAY, LONDON.

The cylinders are 17 in. in diameter and 24 in. stroke, and are placed outside, with the steam-chests inside in the smoke-box. The steam-ports are 13½ × 1⅝ in. and the exhaust-ports 13½ × 2¾ in. The valves have ⅞ in. lap and the eccentrics 2¾ in. throw, the valve motion being the ordinary link.

The driving-wheels are 69½ in. in diameter. The truck-wheels are 36 in. in diameter. The total wheel-base of the engine is 20 ft. 9 in. The total weight of the engine in working order is 104,200 lbs., of which 79,900 lbs. are carried upon the driving-wheels. While running in the open air, the exhaust steam passes through the smoke-stack in the ordinary way, but running in tunnels it is carried back into the tank by the pipe extending backward from the steam-chest, as shown in the engraving.

The engines illustrated are employed on what is known as the "Inner Circle" line. This is 13 miles in length, and in running it 27 stops at stations are required, in addition to which there are generally two or three required by signals. The maximum grade is 1 in 40; there is also an-

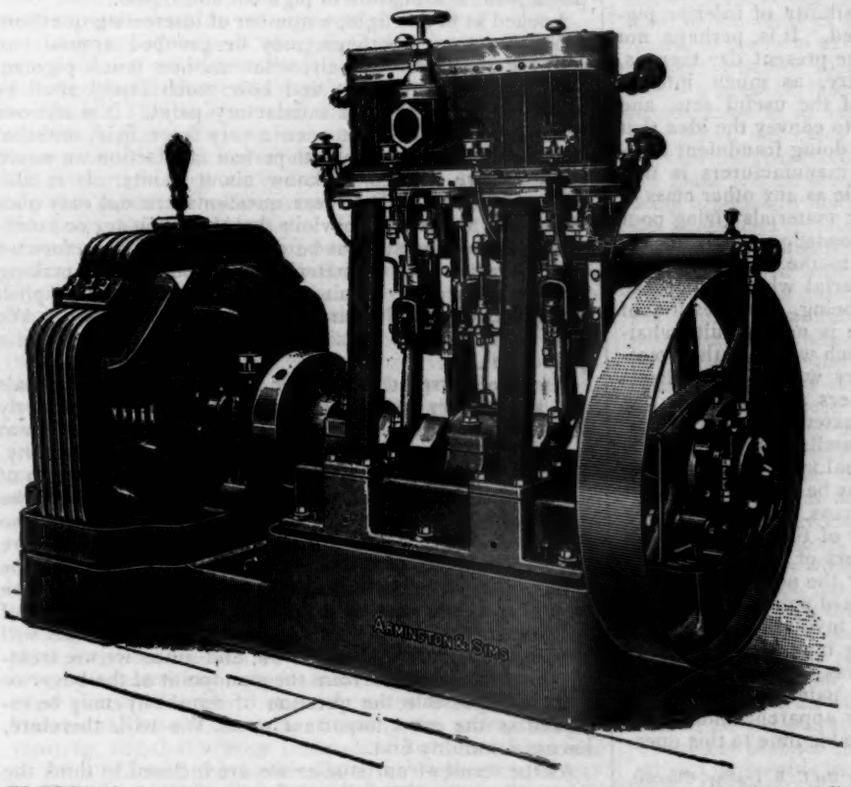
other grade 1 in 45, besides several others varying between 1 in 62 and 1 in 75. The usual train is nine cars, weighing from 75 to 87 tons empty. Almost the entire line consists of curves, the tangents being very short.

For the half year ending December 31 last, the average number of miles run per engine was 15,762, or 2,627 miles per month. They are generally kept steadily at work throughout the day, being in the engine-house one day out of seven. The average coal consumption for the six months mentioned was about 30 lbs. per mile. It may be mentioned that the average time of trains in making the run of 13 miles is 68 minutes, or a little over 11¼ miles an hour, including stops. The engines are fitted with the Westinghouse air-brake, including driver brakes, the air-pump being placed forward of the tank, as shown.

UNITED STATES NAVAL PROGRESS.

THE accompanying illustration, for which we are indebted to the *Electrical World*, shows the plant constructed to run the incandescent lights and the search-light on the dynamite cruiser *Vesuvius*.

The engine and dynamo are mounted on the same base-plate, the connection being made by a flexible Brotherhood coupling. The engine is of the Armington & Sims vertical direct-acting type, with two cylinders, each 5 in. in diameter and 7 in. stroke, the crank-pins being set 180° apart. It is provided with a fly-wheel governor, as shown in the cut. The initial pressure of steam is 60 to 70 lbs., so that a reducing valve is used, the pressure on the ship's boilers being considerably higher. The engine is built to cut off between one-third and one-fourth stroke, and can exhaust into a vacuum or directly into the air. The latest improved lubricating cups are fitted to all journals, both moving and stationary; oil-guards are provided, and the oil-tight base receives the drip, from which it can be drawn off by a suitable cock. The shaft has three bearings, one between the cranks and one on either side, and is built to run at a speed of 500 revolutions per minute.



ELECTRIC LIGHT PLANT FOR THE DYNAMITE CRUISER "VESUVIUS."

The dynamo, which is mounted on the same base, is a Thomson-Houston compound-wound, constant potential generator having a capacity of 50 ampères when generating an electromotive force of 80 volts. It has four poles, the four magnet coils being placed as shown in the cut. Within the magnet coils the iron of the magnetic circuit is not laminated as it is between the coils. The armature is of the Gramme ring type, and, being directly coupled with the engine, makes 500 revolutions per minute when the dynamo is generating its maximum output. The dynamo is both magnetically and electrically insulated from the base by hard rubber bushings and washers about the bolts which hold it in place, and by air space. The insulation from the engine is secured by the leather cushion of the flexible coupling.

The plant was built in accordance with specifications furnished by the Navy Department. The dynamo must have, according to the requirements, not less than 80 per cent. commercial efficiency, and must not be heated more than 60° Fahr. above the surrounding atmosphere after a run of four hours at full load. A variation of only 1½ per cent. from the normal speed of 500 revolutions is allowed to produce the maximum output. In regard to weight, the specifications provided that it should not exceed 1 lb. for every three watts output. The collector is made of hard copper, insulated with mica, with bars 1½ in. deep.

The regulation of the engine speed is required to be not more than 2 per cent. when the load is varied from full load to 20 per cent. of the total or when the steam pressure fluctuates from 60 to 100 lbs. while exhausting into the atmosphere. A variation of 5 per cent. is allowed in the speed between no load and the maximum, or when exhausting either into the air or a vacuum with the steam pressure at about 60 lbs. The tests which have been made of the engine have shown that these requirements have been fully met. The weight of the entire plant was limited by the specifications to 3,000 lbs., or about ½ lb. per watt when working at the maximum output.

The contract for the entire lighting plant was given to the Thomson-Houston Electric Company. The two-wire, metallic return system is used, all wires being lead covered and placed in wooden molding.

The engine and dynamo are certainly an excellent example of a very light and compact plant for service where space and weight are important considerations.

NEW SHIPS.

The gunboat *Concord* has had her preliminary steam trials, and will shortly have her official trials for speed, etc.

The *Philadelphia* has been at the New York Navy Yard, receiving her masts and armament, and will shortly be in service.

Work is already well advanced on the hull of Cruiser No. 7 at the New York Navy Yard, and a considerable force is employed on this vessel; the frames are all in place and much of the plating is on.

At the New York Yard also the *Maine* is making progress. The outside plating is nearly all on, and the ship will be ready to launch in October. The great size and excellent lines of the *Maine* are very apparent in her present condition. The machine shops at the yard are very busy on engine work for the new ships.

The armor of the *Maine* will be put on after she is launched. Her armor-plates, and also the plates for the *Puritan* and the *Terror*—both vessels are under completion at the New York Yard—are being made by the Bethlehem Iron Company.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

XI. PAINTS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(Copyright, 1889, by C. B. Dudley and F. N. Pease.)

(*Continued from page* 364.)

With the possible exception of oils used for lubricating and burning, perhaps no material which railroad companies have to buy is bought with more uncertainty on the part of the buyer, as to the quality of the material he is buying, than paints. Metal, coal, lumber, etc., are either subject to visible inspection or to fairly easily applied tests, which give some idea of the quality of the material, but oils used for lubricating and burning and paints are nothing like so simple. They may be made up of a very large number of constituents, and when once the different materials are put together it is often extremely difficult, and in general to the ordinary buyer impossible to say by any simple means that the material is what it represents itself to be, and this difficulty is, if we reason correctly, greater in the case of paints than in the case of oils used for lubricating and burning, because there is all the liability of the adulteration of the oil used in the paint which occurs in the case of the oils used for lubricating and burning, and there is also the possibility of inferior pigments and inferior driers being used. It is, perhaps, not too much to say that in paints at the present day there is, in general throughout the country, as much inferior material used as in any branch of the useful arts, and when we say this we do not intend to convey the idea that paint manufacturers are in general doing fraudulent business. Our experience with paint manufacturers is that they are as high-toned and honorable as any other class of business men. The use of inferior materials giving poor paints is partly due to lack of knowledge, partly to the stimulus of competition, and partly to the demands on the part of the public for a cheap material which will make an object look well for the time being, the question of durability being laid aside. There is no difficulty whatever in securing good materials which will give the greatest possible durability, and in every way approve themselves in service, provided consumers are willing to pay the necessary price for these good materials.

One point further. It is quite possible that few people who are unacquainted with the actual facts have any conception of the magnitude of what may be called the "paint problem" on railroads. It is, perhaps, not too strong a statement to make, to say that many of the large railroads expend from one-half to three-quarters of a million dollars per year for paints, including under the name paints oils, varnishes, japans, surfacers, and mixed paints used.

In view of the amount of money involved, and in view of the great chances that the buyer may receive inferior materials when he supposed he was buying good, the necessity for a careful study of the paint problem by the great railroad companies is entirely apparent, and in our laboratory we have devoted considerable time to this question for two or three years. It is fair to say that some of the problems are not yet solved, and that no claim is made that the information given below completely covers the ground. The problem is too large and the length of time required in many cases to get satisfactory solutions is too great to have enabled us as yet to get over the whole ground. Some things, we think, are fairly well worked out, and it is these results which we propose to communicate.

Before beginning to give specifications and to discuss the reasons why, it is possible it would be wise to discuss preliminarily several points in regard to paint in general, since a good many points in the specifications depend on the results obtained by a course of experimentation, and these results apply equally well to more than one paint.

The first question which we will discuss is, What is paint?

In a very broad way paint may be said to be any liquid or semi-liquid substance applied with a brush to protect or give color or gloss, or all three, to surfaces. In this sense both whitewash and varnish might be regarded as paints. We do not at present, however, intend to discuss the question from quite so broad a standpoint. The form in which we propose to discuss the material is more from the standpoint of the composition of the paint, and a better definition for our purposes would be that paint is a material consisting of pigment and liquid, usually applied to surfaces with a brush for purposes of protection and ornament, or to secure artistic results, which liquid, after having undergone certain changes, has the power of holding the pigment to the surface. Briefly, then, for our purposes paint is a mixture of pigment and liquid.

Looked at in this light, a number of interesting questions arise, but these, perhaps, may be grouped around two primary questions—namely, what and how much pigment shall be used, and what and how much liquid shall be used in order to make a satisfactory paint. It is obvious that these two questions open a very large field, and that if we could answer them with perfect satisfaction we would know all we wanted to know about paints. It is also obvious, we think, that these questions are not easy ones to answer, and equally obvious that the requisites or essentials of a good paint must be clearly decided on before we can say what kind of materials shall be used in making the paint, since the result which we want to accomplish will go far toward deciding the materials to be used. We will, therefore, first consider what are the essentials of a good paint.

As we understand the matter, the requisites or essentials of a satisfactory paint are (1) that it shall work properly during its application; (2) that it shall dry with sufficient rapidity, and (3) that it shall have the proper durability. The working qualities of a paint are largely a question of the relative amounts of pigment and liquid, but both the nature of the pigment and the nature of the liquid also have influences. The drying qualities of a paint are largely a function of the kind of liquid used, although the pigment also has an influence to a certain extent. The durability of the paint is a function, both of the nature of the pigment and of the liquid. Each of these points will be discussed in detail further on, and since we are treating the matter of paint from the standpoint of the buyer or user, it is possible the question of durability may be regarded as the most important one. We will, therefore, discuss durability first.

As the result of our studies we are inclined to think the destruction of paint follows from seven causes: First, mechanical injury; second, the action of deleterious gases; third, peeling; fourth, the action of light; fifth, chemical action between the pigment and liquid; sixth, destruction during cleaning; seventh, water.

Of these seven causes, possibly the destruction during cleaning and the action of water are the worst, although all of them have their influence, and there may be cases in which some one of the others is most efficient in producing the destruction of that particular paint at that particular time. We will try to discuss each of these causes a little in detail.

1. *Mechanical injury* is not a very serious cause of deterioration of paint except in certain localities. At the sea-shore it has been recognized for a long time that the

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, is on the Work of the Chemist on a Railroad; No. II, in the January number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the method of purchasing oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

paint was so injured by the sand blown against the buildings, that the durability of the paint was not as great as it otherwise would have been. Also the action of cinders on cars is a recognized cause of deterioration of the paint. Of course the best means of preventing this is apparently to have the paint coating as elastic as possible. The harder or more brittle the coat of paint is, the worse will be the destructive action of either cinders or sand. It seems probable, however, that the mechanical injury, except possibly at the sea-shore, is not a very efficient cause of the destruction of paints.

2. The action of *deleterious gases* is very familiar to those who have studied paints at all. In our experience white lead is the most readily acted on in an injurious way by deleterious gases, and the gas most destructive is sulphuretted hydrogen. It is not at all uncommon to see a building painted with white lead become quite black from the formation of sulphide of lead. Subsequent rains remove the sulphide of lead, and in this way the coating of paint is wasted away. We do not remember to have run across any clearly defined case of the destruction of paint due to noxious gases except sulphuretted hydrogen, and, as said above, white lead is apparently the paint which suffers most severely from this cause. The obvious remedy for the destructive action of deleterious gases is to use, if possible, pigments which are not affected by these gases. We have never demonstrated any deleterious action on the binding material which holds the pigment to the surface, although it is probable that ammonia, which may occur in small amounts in the atmosphere, might have deleterious action on the binding material and possibly in some cases on the pigment.

3. *Peeling.*—It is well recognized that in certain places paints do not adhere well to the surfaces, and it is also well recognized that certain paints do not adhere as well as others. This is a marked characteristic, so far as our experience goes, of white zinc—namely, that it peels. We have never noticed any other pigment which possesses this property in any marked degree. It is difficult to say why this pigment should peel so badly. The most plausible theory which we have ever run across is that the zinc white combines with the oil used in the paint, forming a species of zinc soap, and this zinc soap we know to be a brittle, non-adhesive substance. We do not think this theory has ever been definitely established by experiment, and give it for what it is worth. It is also well known that certain surfaces, notably galvanized iron, do not hold paint. The common appearance of many passenger cars, the roofs of which are covered with galvanized iron, is a striking commentary on this fact. Perhaps no worse material could be used for car roofing, provided it is intended to paint the roof, than galvanized iron. Experiments recently made, continuing three years, show that of six different kinds of paint but one maintained itself over the galvanized iron, and this was a patented paint, the composition of which has not yet been worked out. There is very little doubt but that where ordinary paints must be used galvanized iron is the worst material for car roofing. The reason why galvanized iron does not hold paint has been speculated on quite a little, but we have never yet heard any very satisfactory explanation. The most plausible theory that we know of is that, as is well known, sal ammoniac is used during the process of galvanizing, and that a little basic chloride of zinc is formed on the surface of the metal during the operation of galvanizing, which material, being more or less hygroscopic, repels or prevents close adherence between the paint and the surface. We do not think this theory has ever been established, and regard it as of not very great probability, especially as it is claimed that even sheet zinc, which has never been through the galvanizing bath, likewise does not hold paint well. Apparently the truth is that all paints do not adhere to all metals. Some paints, as above described, adhere pretty well to galvanized iron, and the same paints peel over lead, while those which adhere to lead and tin do not adhere to zinc. No very positive general statement can yet be given, and the field of the adaptability of paint to metal still needs study.

4. *The action of light* on paints is not thoroughly well understood. There seems little doubt but that some of the organic coloring matters used in paints are faded by the action of light. It is also possible that the action of light may facilitate chemical action between the pigment and the liquid. No very positive experiments have ever been made on the action of light more than to discover whether certain pigments were faded by exposure. In general it may be stated that pigments containing organic coloring matter, including coal-tar dyes or coloring matter obtained from dye woods, etc., fade more or less when exposed to the light, and some of them quite rapidly, and that this fading is supposed to be due to the action of light. We do not know that this has been absolutely demonstrated.

5. *Chemical action* between the liquid and pigment is a largely unknown field, but in our judgment is an exceedingly important one. It is well known that the liquid in common use in paints is linseed-oil, and that linseed-oil is capable of saponification. It is also well known by those who are at all familiar with chemistry, that soda and potash are not the only substances which combine with fats to make soap. We may have iron soap, lead soap, manganese soap, and zinc soap, or, indeed, almost any of the bases might be combined with the fat acid of the oil, forming soap. The chemical action which may take place between the liquid and pigment may therefore be a saponification under the influence of the water during a rainfall, and of the heat produced by the sun. It is well known that many of the pigments are simply oxides or hydrates, in the same way that soda and potash are; notable examples of these are white lead, which is carbonate and hydrate mixed, oxide of zinc, oxide of iron, oxide of lead, in the form of red lead or litharge, oxide of chromium, in the form of chrome green, etc. It is, of course, a query whether these oxides do combine with the oil forming soaps of these various bases. In some cases this combination is at least strongly suspected, although in very few if any cases has it been demonstrated. Assuming that the combination does take place, it is evident that the paint left on the surface after a few years, instead of being a pigment, held to the surface by the liquid, which has undergone certain changes called drying, is in reality a new chemical body, consisting of the constituents of the liquid combined with the pigment, or, in other words, may be a soap. The possibility of the formation of a zinc soap has already been hinted at above. It seems probable likewise that with white lead there may be such a combination, resulting in the formation of a lead soap. It is, of course, impossible in the present state of our knowledge to affirm that these results actually do take place, but there seems strong probability that the deterioration and wasting away of some paints, notably zinc white and white lead, may be due to this cause. Positive experiments made with some of the soaps which are insoluble in water show that they are not at all durable. This is notably the case with lime soap, which makes a varnish which gives an elegant gloss when dissolved in turpentine and applied in the usual way, but which, when exposed to the weather, goes to pieces in a few months. If, therefore, some of the soaps which it is possible may be formed by action between the oil and pigment, as above described, should prove, like lime soap, to be of small durability, the chemical action between the oil and pigment would explain a good deal of the deterioration of paints.

Another possible chance for chemical action between the oil and pigment is in those paints which contain pigments which readily give up oxygen, or which readily break up in the presence of organic matter. It is well known, for example, that hydrated oxide of iron, under certain conditions at least, oxidizes organic matter and destroys it. It is also well known that chromate of lead will readily oxidize organic matter. It is possible still further that Prussian blue, in contact with the oil or other organic matter of the liquid, may undergo decomposition. The well-known tendency of chrome yellows, when used as paints, to turn greenish by exposure, may possibly be accounted for in this way. It will be observed that these things are all spoken of as possibilities. We use these words because we do not think the possible chemical changes between oil and pigment, as already stated once or twice, have been worked out, and therefore we cannot

say that the possibilities mentioned above do actually take place. The probability that such chemical changes may take place is so strong, however, that we should give a good deal of force to this probability in compounding paints, and in all our work in devising formulæ for paints we have constantly borne in mind the possibility of chemical action between the pigment and the liquid, and likewise, so far as our chemical knowledge goes, have tried to avoid such pigments as from their chemical nature may result in any action between the liquid and the pigment. The whole field sadly needs study and investigation, and at present all we can say is we try to use as much pigment which from its nature is chemically inert, and as little pigment that is chemically active, as possible. To our minds the well-known fact that white lead mixed with barytes or other inert material lasts longer than pure white lead, is explained on the supposition that the white lead combines chemically with the oil, forming a chemical body which is not as durable as dried linseed-oil with an inert pigment.

6. *Destruction during cleaning* is certainly a very potent cause of the deterioration of paint. This subject will be discussed somewhat at length when we come to the article on soaps. At present it is perhaps sufficient to say that almost all the binding material of dried paints, including varnish, is more or less acted on by caustic and carbonated alkalies, and, as is well known, very little soap in the market is free from either caustic or carbonated alkalies. The ordinary sal soda, also known as washing soda, which is so commonly used by domestics in houses, either with or without soap, in cleaning paint, is a very potent cause of the destruction of paint. Two or three good cleanings will frequently take a good portion of the paint from a door, and in our experience in car cleaning it is not rare to find the varnish almost wholly destroyed and the paint itself seriously injured as the result of cleaning. Many of the highly recommended detergents of the market are simply mixtures of sal soda with some inert material, and they certainly do take off the dirt with great rapidity, but they also remove the varnish and paint with equal rapidity. Some method of cleaning paint without destroying it is a very great desideratum. We will give our experience on this point and our present practice a little later, satisfying ourselves here with putting on record our belief that the cleaning of paint is one of the most fruitful causes of its destruction.

7. In our belief *Water*, if we lay aside the rapid destruction due to cleaning, as above described, is the most potent cause of deterioration and wasting away of paint. Several instances may be cited which point strongly in this direction. It is well known that the lettering on old sign-boards is perhaps the most durable paint that is exposed of which we have any record. Almost every one will remember old sign boards on which the letters stand out in relief, the paint in the interstices between the letters being gone entirely, and in some cases the wood having vanished to a greater or less extent. On examination it is found in such cases, we believe, that the sign-board was originally covered with several coats of white lead, and that over the white lead lamp-black letters were placed, and that the lamp-black letters have protected not only the paint over which they were applied, but also the wood underneath. This phenomenon, to our minds, is explained by the well-known fact that lamp-black is one of the best substances to repel water that is known. Being somewhat oily or greasy in its nature, and being itself practically indestructible, it preserves whatever is under it from destruction. We are inclined to think this would not be the case if the lamp-black allowed the water to get in underneath it to the white lead.

Again, it is well known that inside painting lasts very much longer than outside painting, largely, we believe, because the outside painting is exposed to rain, while the inside painting is protected. It is true the action of gases and light are more severe on the outside painting than on the inside painting, but we do not think the difference can be accounted for in this way.

There is still further proof that water is very destructive to paint—namely, direct experiments show that dried linseed-oil is not water resistant or water repellent. We made some experiments by coating pieces of glass with ordinary linseed-oil, and allowed them to dry and harden for a couple of weeks. These coated glasses then had water placed upon them, and were covered so that the water would not evaporate. To our astonishment, when we examined the glasses the next morning we found that the dried linseed-oil had soaked up water, and wherever the water had touched it the coating presented the appearance of a shriveled apple. On allowing the water to evaporate the coating dried down again to its place; but it is quite evident that the dried linseed-oil did not repel water, and that under the action of the water disintegration was taking place. Dried linseed-oil containing pigment is a different matter, as will be explained later, and it is also possible that, as time progresses, dried linseed-oil may so change chemically that it is less readily acted on by water. Our experiments do not give definite proof on this point, but we are very strongly convinced that the action of water is, all things considered, the most potent cause in the deterioration and destruction of paints. Indeed, we have already put some study on the question of rendering the paint water-proof, and we know of others who have spent a great deal of time in trying to develop a water-proof coating to go over paints and varnishes. Our belief is that if any good paint could be rendered absolutely water-proof, its durability both in protecting the surface and in appearance would be more than doubled, and we do not at the moment know of any field in which the reward would be more sure and abundant than for some simple device which would render ordinary paints incapable of being acted on by water.

Our belief in the destructive action of water on paint is so strong that we use a water test as a quick method of arriving at the durability of any proposed mixture. It is obvious that if, with experiments on paints, we had to wait five or ten years to demonstrate their durability, it would make the study of the subject so long continued that a lifetime would hardly suffice to solve only a few points, and accordingly, in our first attempts to study this question, we looked around for some means which would give us a quick durability test. After looking over all the possible causes of deterioration, as above described, we decided that water alone was the chief single cause, and, as said above, if a proposed paint or mixture does not stand under water for a period of time without change we regard it as inferior. We really know of no single quick test so good as simply to expose the paint to water for a few hours. It is not at all strange to find as the result of such a test both changes in the shade of the pigment and changes in the integrity of the paint.

It is obvious, we think, from the discussion above that to obtain a paint which will be durable is not so simple a matter, and also that the amount of actual knowledge which we have on the subject of the durability of paints is small compared with the unknown field. To design a paint, if we may use the expression, which will successfully withstand some of the deteriorating causes mentioned above, is not so difficult a matter. For example, to get a paint which will stand mechanical action most successfully, it must be made as elastic as possible by using rather a small proportion of pigment and more of the liquid, and also use the least possible amount of japan and no gums or varnish in the liquid. To make a paint which will successfully stand the action of deleterious gases, use no pigment which will be acted on by the gases which prevail in the locality. To avoid peeling of the paint, use on the surface a paint which experience has shown will adhere to that kind of surface, and avoid those pigments or mixed paints which peel from any surface. Again, to antagonize the action of light on paint, use pigments which do not fade, which is probably the best which can be done at the present moment. To successfully meet chemical action between pigment and liquid, of course chemical knowledge is required; and although the field covered by actual demonstration is yet small, still there is enough known, so that we think certain pigments should be avoided entirely. To successfully withstand destruction during cleaning, such methods of cleaning should be used as will be least injurious to the paint. We will give our best knowledge on this subject later. But to get a paint which

will successfully withstand the destructive action of water is, as has already been hinted at, an enormous field, and but very little positive knowledge has yet been obtained.

One or two points, we think, however, are known. We made the following experiments. Several samples of paint were made, consisting of linseed-oil with a very slight amount of japan and varying amounts of the same pigment. No. 1 was simply linseed-oil and japan alone. No. 2 was the same liquid 90 parts, pigment 10 parts. No. 3 was the same liquid 80 parts, pigment 20 parts. No. 4 was the same liquid 70 parts, pigment 30 parts. No. 5 was the same liquid 60 parts, pigment 40 parts. No. 6 was the same liquid 50 parts, pigment 50 parts. No. 7 was the same liquid 40 parts, pigment 60 parts. All the proportions were by weight. The proportions of liquid and pigment higher than 40 of liquid and 60 of pigment will not spread well with a brush if linseed-oil is the liquid, and the pigment has the specific gravity which is characteristic of ordinary iron oxide paints. Two coats of each of these paints were painted on glass and allowed to dry and harden for two or three weeks. They were then placed side by side, and a small portion of the surface of each covered with a globule of water. This globule was covered to prevent evaporation, and the whole thing allowed to stand for 12 to 14 hours. On examination at the end of this time the No. 1 coating was found to have cleaved off from the glass and become shriveled wherever the water had touched it. Apparently the dried linseed-oil had soaked up water, much as a sponge soaks up water. On allowing the water to evaporate the coating dried down again, but not uniformly, and was apparently weakened in texture. No. 2 showed the same phenomenon, but in less degree; No. 3 the same, but in still less degree. No. 4 did not cleave off from the glass, but showed where the water had stood. No. 5 showed a spot in the same way, but in less degree than No. 4. No. 6 and No. 7 showed very slight if any action. We are inclined to think, as the result of these experiments, that a large percentage of pigment is one of the things which is essential to secure durability of paints. Many times we have been asked to use paints which contained very large amounts of coloring matter, the argument being that there was so much of the color that it would bear thinning with a great deal more oil, and therefore would cover a great deal more surface. To our minds the experiments detailed above show that this is fallacious reasoning, and that as much pigment as will give a good spreading paint is a strong element in the durability of the paint.

One point further only. The quantity of pigment present apparently has an influence in protecting the paint against water. Also we are confident the nature of the pigment is a powerful element in protecting the paint against water, and in proof of this we point to the action of lamp-black, as already cited. These two points—namely, amount of pigment and kind of pigment, are, so far as our knowledge goes, the most definite knowledge that we have as to how to preserve paints against the action of water.

In addition to the fact mentioned above, that freshly dried-linseed oil not only does not repel water, but actually soaks it up, it seems probable that the ammonia in the air, as previously mentioned, and which is brought down by the rains, may be a potent cause of the gradual wasting away of paints, since it is well known that ammonia dissolves not only varnish, but also dried linseed-oil, quite readily. It would probably be too much to say to claim, as has been suggested, that the destructive action of rain-water on paints is principally caused by the ammonia that the rain water contains, but we cannot but feel that the slow wasting away of good paints, which have been hardened by age, is at least facilitated by this cause.

The specifications, which we will give later, for certain paints will show how we have studied the problem, and what measures we have taken to antagonize the various deteriorating causes.

In the next article we will discuss the other two points of the essentials of a paint—namely, rapidity of drying and proper working under the brush, and then take up the questions of what and how much liquid to use, and what and how much pigment to use

(TO BE CONTINUED.)

AËRIAL NAVIGATION AND WIND PRESSURE.

To the Editor of the Railroad and Engineering Journal:

IN the interesting and instructive paper on Aërial Navigation in the July issue of your JOURNAL, the statement is made that according to the experiments of Hutton and of Borda, "The resistance of a sphere is 41 per cent. of that of a flat surface of area equal to its mid-section."

Several years ago, while acting as Consulting Engineer of the large and fine Capitol building at Des Moines, Ia., and not being able to find in print or elsewhere the facts needed, the writer considered the subject of wind pressure upon spherical, cylindrical and conical surfaces with a view to finding the effect of the wind upon the hemispherical dome of the building referred to. This discussion was a few years afterward somewhat enlarged by comparing Duchemin's hypothesis with his own, and was published in *Van Nostrand's Engineering Magazine.*

In this discussion the normal pressure; the x, y and z components of that pressure; the moments of these components; the points of application of their resultants; the shearing strain between the dome and the superstructure, etc., are found. It is shown, for example, that the wind tends to distort the dome laterally and vertically, but not in the direction of the wind, and the forces which produce the distortion are computed. Adopting the hypothesis of Duchemin, it is found that the resistance of a sphere is 0.6136 of that of a flat surface of area equal to its mid-section According to the hypothesis of the writer it is found that the resistance of the sphere is 0.6666 of that of a flat surface of area equal to its mid-section. It follows that the resistance of a sphere is, according to the hypothesis adopted, 0.3068 or 0.3333 of that of a flat surface of area equal to the area of the surface of the hemisphere exposed to the wind.

Since the article referred to gives the wind pressure upon cylindrical and conical surfaces, and by implication upon any surface, it is believed to be convenient in connection with the designing of balloons, towers, stand-pipes, etc., as therein pointed out.

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A PROBLEM IN LAND SURVEYING.

BY F. HODGMAN, C.E.

TO *correct a random traverse of several courses between two known points.*

Desired, a general solution which shall be the best for practical application in the field; also the results of such a solution as applied to the example given below.

Example.—A highway between nearest known points is described as follows:

1st.	N. 62° E.,	14.00	chains.
2d.	N. 43½° E.,	8.00	"
3d.	N. 5° W.,	12.00	"
4th.	N. 72½° E.,	10.25	"
5th.	S. 12° W.,	6.43	"

A random run with variation of needle 2° 17′ E. came out 62 links east of the point. Stakes were set at the angles of the random.

1. What is the variation of the needle as referred to the meridian of the original survey of the highway?

2. How much, and in what direction, must the stakes in the angles of the random be moved, to place them in the angles of the original line?

Answers to this problem from readers of the JOURNAL will be acceptable.

Swimming Gloves.—A Spanish gentleman has, according to the London *Drapers' Record*, patented an invention relating to the manufacture of gloves having webs between the fingers, like those on the feet of water-fowl, so that on spreading out the fingers during the propelling stroke in swimming, a comparatively large surface will be presented to the water, and consequently the propelling action will be greatly increased.

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

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(*Continued from page 374.*)

CHAPTER V.—(*Continued.*)

ELEMENTARY PRACTICE.

Bolts such as have been represented in the examples given last month are generally finished—that is, the shanks, ends, tops and bottoms are turned off in a lathe, screw threads are cut on the shanks, the sides of the heads are filed or finished in a machine, and a nut is screwed on the thread. Figs. 141–143

Fig. 141.

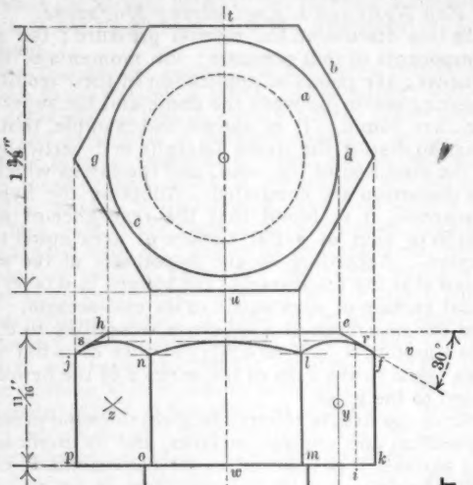
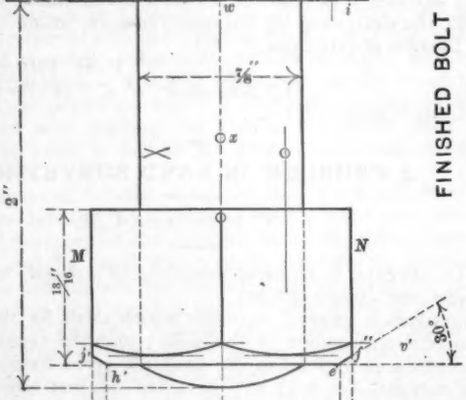
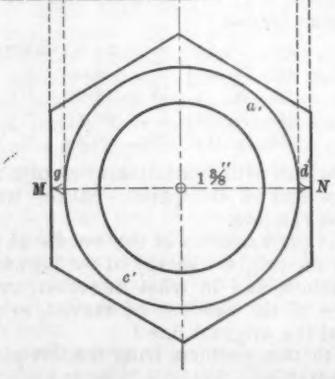


Fig. 142.



FINISHED BOLT
Full Size — Aug. 10, 1890

Fig. 143.



represent a finished bolt and nut drawn full size. In turning it its diameter has been reduced from 1″ to ⅞″, and all the dimensions of the head have been diminished by taking off a part of the metal in finishing. The thread is not drawn in the bolt, but the method of doing it will be explained in a future chapter. No further explanation of the method of making the drawing is needed except to explain how the chamfer or bevel on the top of the head and nut is represented. The top corners of bolt heads and nuts which are finished are usually beveled off to improve their appearance and to make the corners less prominent. Usually the bevel is carried in a short distance inside of the sides of the head or nut, as shown at *a*, fig. 141. The incline *e f* and *e' f'* of the bevel is generally about 30° with the top of the head, which is indicated by dotted lines at *v* and *v'*, fig. 142. To represent it on the plan of the head and nut, all we need do is to draw circles 3 *a c* and *a' c'*, figs. 141 and 142, the required distance, inside of the sides of the head. In the side view, fig. 142, the problem is a little more complicated. If with a triangle we draw perpendicular lines, *d e* and *g h*, tangent to the circle *a c*, and extend or "project" them down to the top, *h e*, of the head, then *h* and *e* will be the points of beginning of the bevel *e f* and *h j*, which may be drawn with a 30° triangle.

If the learner will take a bolt head or nut which has been chamfered in this way he will find that in the side view lines are shown where the beveled surface intersects the sides of the head. To show these lines with absolute correctness is a somewhat complicated problem, but the following method gives results which are correct enough for practical purposes: In the side view, fig. 142, which represents the head across the corners, draw the bevel *e f*, as explained. Then from the intersection of the bevel, *e f*, with the corner *f k*, draw horizontal lines intersecting at *l n* and *j* the vertical lines *l m*, *n o* and *j p*, which represent the corners of the head. Next draw a perpendicular

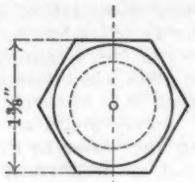


Fig. 144.

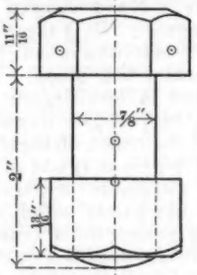


Fig. 145.

Fig. 146.

line, *r i*, at a distance, *i w*, from the vertical center-line equal to one-half the width or diameter, *t u*, of the head = 1⅛ in. From the point of intersection *r* of *r i* with the bevel *e f*, draw a horizontal pencil line *r s*. Then by drawing arcs of circles, *f l*, *l n* and *n j*, tangent to *r s* and passing through the points *f l n* and *j*, they will represent the lines of intersection of the beveled surface with the sides of the head. The center *x* of the curve *l n* is on the center-line of the bolt, and it and the radius may be found by trial. To get the centers *y* and *z* and radius of the curves *f l* and *n j*, draw a vertical pencil line at *y* half way between *l m* and *f k*. Then by trial get a radius whose arc will pass through *l* and *f* and be tangent to *r s*. With this radius, and *n* and *j* as centers, describe intersecting arcs at *z*, which will give the center of *n j*.

From figs. 142 and 143 it will be seen that the nut *N*, instead of being represented "across the corners," as it is called, is shown in fig. 142, with two of its sides, *M* and *N*, parallel with the "line of vision," or with the direction in which a person is supposed to be looking at the bolt. Therefore, only two of its sides are shown, instead of the three which are seen in the side view of the head. To show the bevel on the nut, the points *e'* and *h'* are located in fig. 142 by drawing a line *e' d'* tangent to the circle *c' a'*, as explained above. The bevels *e' f'* and *h' j'*, and their curved intersections with the sides of the nut, are then drawn in fig. 142, in the same way as has been described for drawing the head.

As remarked above, the screw-thread of the bolt is not shown in the engravings. To represent it correctly is a difficult problem, which will be explained in a future chapter. Gener-

ally, in making working drawings of bolts, it is sufficient to show the bolt where it passes through the nut by dotted lines, as in fig. 142.

Figs. 144–146 represent the bolt drawn to a scale of 6 in. = 1 ft., or "half size." It will be good practice for the learner to draw the bolt both sizes, so as to familiarize himself with the use of different scales.

WRENCH.

Figs. 147 and 148 represent a common wrench, half size. To draw this, the first thing to be done is to lay down a center line *e o*. From some point, *a*, as a center, near the end of the line, draw a circle *e b b*, whose diameter, *m m*, is equal to the width of the bolt-head or nut measured across its sides, or its *short diameter*, as it is called. Circumscribe this circle with a hexagon, as shown. In order to hold the nut securely, the wrench should project slightly beyond the corners of the nut at *d d*. Having laid down these two points, draw lines *a c* and *a c* through *a*, and at 45° with *e o*; then *b b*, the points of intersection of these lines with the circle, will be the centers of the curves *c d*, *c d*, which should be drawn through *d* and *d* with a radius *b d*. Another curve, *c k c*, should then be drawn from the center *a* with a radius *a r*, and tangent to *c d* and *c d*. The length of the handle of the wrench from *n* to *o* should be about eight times the width *m m* of the nut. The width *p p*, at the end of the handle, should be three-quarters the width of the nut. Having laid off the length of the handle from *n* to *o*, draw a semicircle *p o p* through *o*, and extend the lines *d f*, *d f*, so as to intersect *c k c* at *g*, *g*. Then, from *g*, *g*, draw lines *g p*, *g p*, tangent to the semicircle, and with a radius $h = b\,c$ draw curves *c r*, *c r*, tangent to *c k c* and *r o*.

To draw the wrench looking at it edgewise, first lay down a center line *D d*, fig. 148. For the thickness *C* of the head of the wrench, take three-fourths of the thickness of the nut measured lengthwise to its bolt. Lay this off from the center-line *D d*. *D*, the thickness of the handle, should be one-half as much as the head, which should be laid off in the same way.

To draw the curves which unite the head with the handle of the wrench, draw a line *i j* from *i*, in fig. 147, where the curve *r c* joins *c k c*. Then, from *j* and *j'*, where *i j* intersects the sides of the head, draw curves tangent to the sides of the handle. A similar method should be followed to show, on fig. 148, the curves *l r* and *l' r'* formed where the handle joins the head at *k*, fig. 147.

Fig. 147.

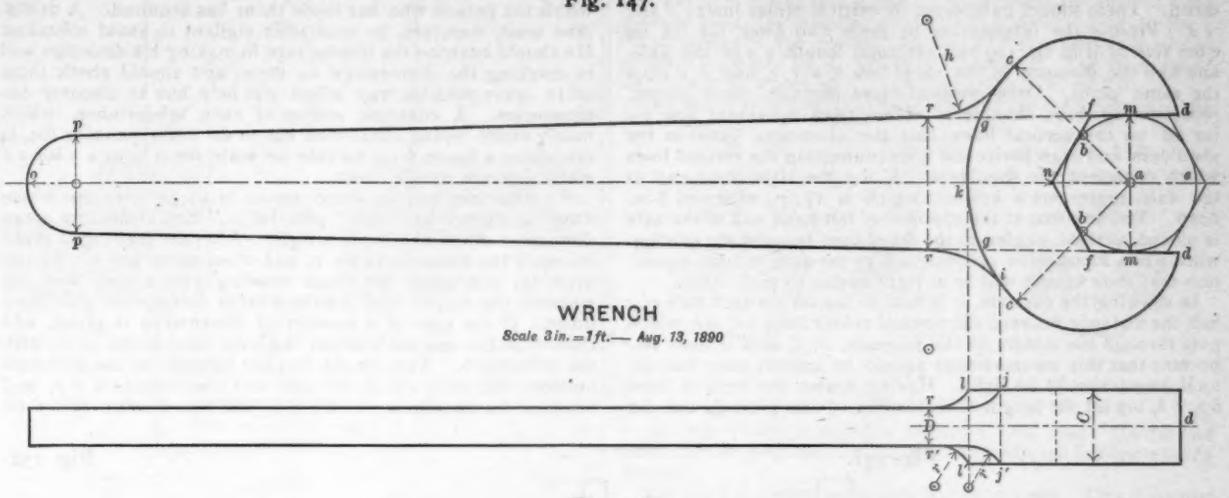
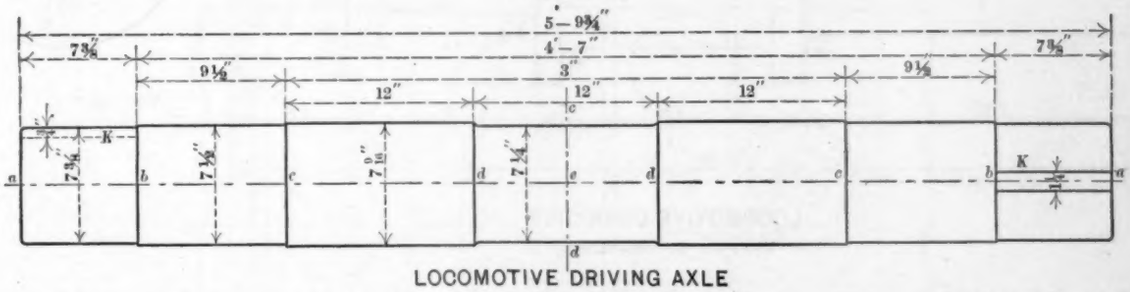


Fig. 148.

Fig. 149.



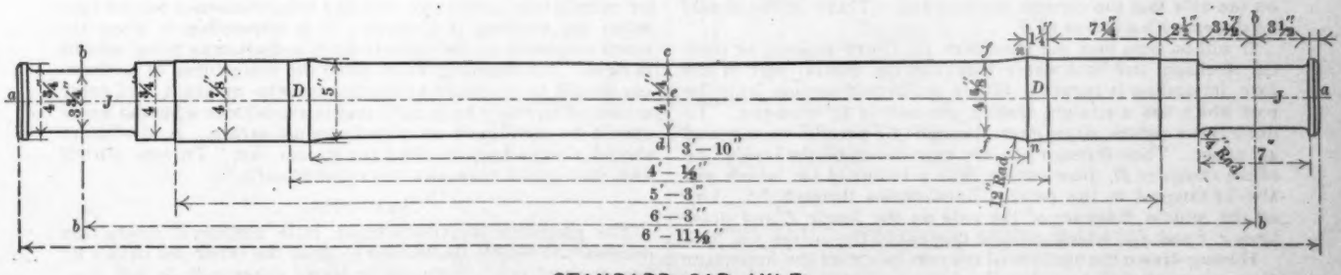


Fig. 150.

LOCOMOTIVE AND CAR-AXLES.

Figs. 149 and 150 represent respectively a locomotive driving-axle and one of the standard car-axles recommended for general use by the Master Car Builders' Association. The learner is recommended to draw this to a scale of 3 in. = 1 ft. To do this, horizontal center lines *a a* and *a a* should first be laid down. These should be bisected by vertical center lines *c d* and *c d*. From *e*, the intersection of these two lines, lay off on each side of it in fig. 149 half the total length *a a* of the axle, and half the distance of the shoulders *b*, *b*, *c*, *c*, and *d*, *d* from the same point. Draw vertical lines through these points, representing these shoulders. Then, from the center line *a a* lay off on the vertical lines half the diameters between the shoulders, and draw horizontal lines connecting the vertical lines which represent the shoulders. *K*, on the right-hand end of the axle, represents a key seat which is 1¼ in. wide and ⅜ in. deep. The key-seat at the opposite or left-hand end of the axle is placed at right angles to the other one, because the driving-wheels of a locomotive are fastened to the axle in such a position that their cranks will be at right angles to each other.

In drawing the car-axle, it is best to lay off on each side of *e* half the distance between the vertical center lines *b b*, *b b*, which pass through the middle of the journals, *J*, *J*, as it is more important that this measurement should be correct than that the total length should be right. Having drawn the vertical lines *b b*, *b b*, lay off the length and diameter of the journals and the collars *a a*, and draw the lines representing them. It will be noticed that where the journals join the collars and the shoulders on the axle that the corners are rounded. These curves should be drawn with a radius of ¼".

It will be seen that the shoulders *D*, *D* are tapered or conical in shape, and that where they join the central part of the axle, its outline is curved. Where the curved portion joins the part which has a straight outline, the axle is 4½" diameter. To draw these curves, draw lines through *f f* parallel to *a a* and 4½" apart. Then through *n n*, the extremities of the inside line of the shoulder *D*, draw curves, with a radius of 12", which will also be tangent to the parallel lines drawn through *f f*. Lay off the middle diameter of the axle on the line *c d*, and draw lines *c f* and *d f*, which must be tangent to the curves *f n*, *f n*.

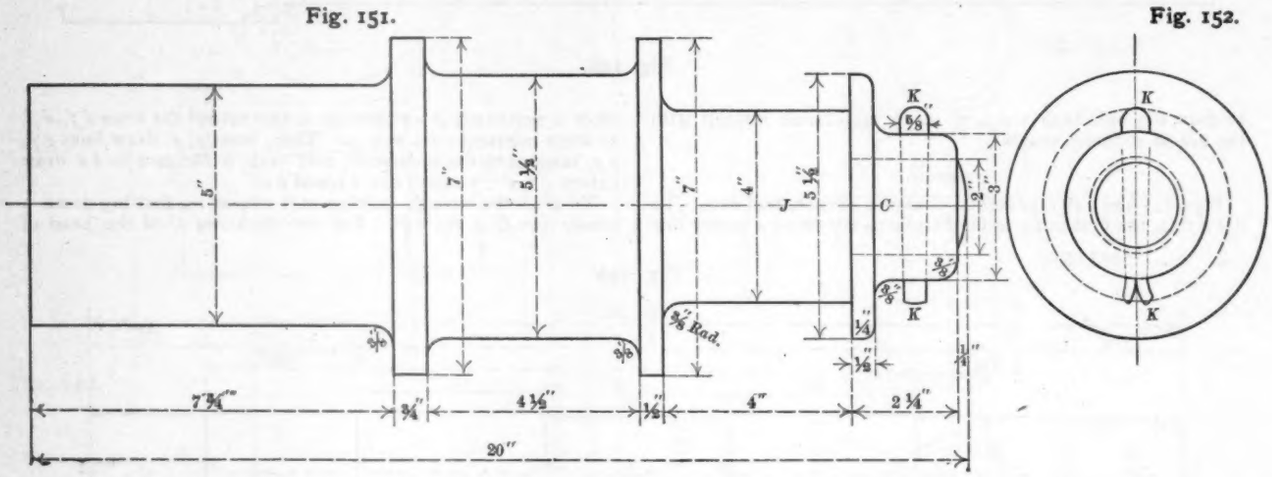
Having drawn the outlines of the two axles, all the important dimensions should be given in figures on the drawing. It should be remembered by the learner that every dimension which he requires to draw the axle will be needed by the mechanic who forges or finishes it, and therefore they should all be marked on the drawing, as has already been explained. No general directions for doing this can be given. In drawings of objects with two ends alike similar to the two axles, it is best to mark the dimensions of length on one end of the drawing, and the cross measurements on the other end. If the dimensions or dimension lines are liable to confuse the drawing, the latter should be carried out to one side of the drawing, as has been done in a number of the examples. The student can be guided by the engravings, but it should be noticed that it is essential to give not only the short dimensions, as the distance between the shoulders of the axle, but also the distances *over all*, and these *must* agree with each other.

MISTAKES.

The learner should keep in mind that the most inexcusable fault in a draftsman is a mistake. No other merit will atone for making blunders. They are expensive and always annoying, and no repentance over the consequences of errors will defray their cost or fully restore the reputation for carelessness which the person who has made them has acquired. A draftsman must, therefore, be constantly vigilant to avoid mistakes. He should exercise the utmost care in making his drawings and in marking the dimensions on them, and should check them off in every possible way, which will help him to discover discrepancies. A common source of such misfortunes, which nearly every young draftsman has to do bitter penance for, is mistaking a figure 6 on his rule or scale for a 9 or a 9 for a 6 when they are upside down.

An excellent way to detect errors is to go over the whole drawing when it has been "penciled in," and remeasure every dimension to see whether it is right. After the drawing is inked in, mark the dimensions on it, and when these are all on the drawing, remeasure the whole drawing with a scale and see whether the figures and measurements correspond with each other. If the sum of a number of dimensions is given, add them together and see whether the long dimensions agree with the calculation. Thus, in fig. 149 add together all the distances between the ends *a a* of the axle and the shoulders *b b*, and between the shoulders *c c* and *d d*, and see whether the total distances between *a a*, *b b* and *c c* are the same as the sums of the short dimensions. If any of the figures have been obtained by calculations, always go over the computations a second time when the drawing is finished. It is impossible to place too much emphasis on the importance of a draftsman being sure he is right. No lingering doubt about the correctness of a drawing should be tolerated by the person who makes it, and every means of knowing he is right that is available to a human being should be employed to guard against errors. A draftsman should always keep in mind the maxim that "THINGS WHICH ARE NOT QUITE SURE ARE VERY UNCERTAIN."

Fig. 151. Fig. 152.



LOCOMOTIVE CRANK-PIN

Scale 3 in.= 1 ft.— Aug. 13, 1890

CRANK-PIN.

The preceding directions make little additional instruction necessary to enable the learner to draw the crank-pin shown by figs. 151 and 152. It should be drawn either half or full size. *C* is a collar which is screwed on the end of the pin to hold the coupling-rod on the journal *J*. The tapered pin or key *K K* passes through the collar and the screw to prevent the collar from unscrewing. The lower end of the key is split, and the two parts are bent apart, as shown in fig. 152, to hold the key in its place.

ARROW HEADS.

In figs. 125–139, given last month, the arrow-heads on the dimension lines are represented as though they were drawn "by hand" with an ordinary writing pen. In the illustrations given this month, it will be noticed that the arrow-heads are drawn with a pair of spring-compasses, which gives the drawing a much neater appearance. Either method may be used, but if neatness is aimed at, the compasses should be used in doing this work.

RIVETS.

When two metal plates or flat bars are to be fastened together, the simplest way of doing it is with rivets. The plates or bars are made to overlap each other, and holes are either drilled or punched in them to receive the rivets. They are made with a

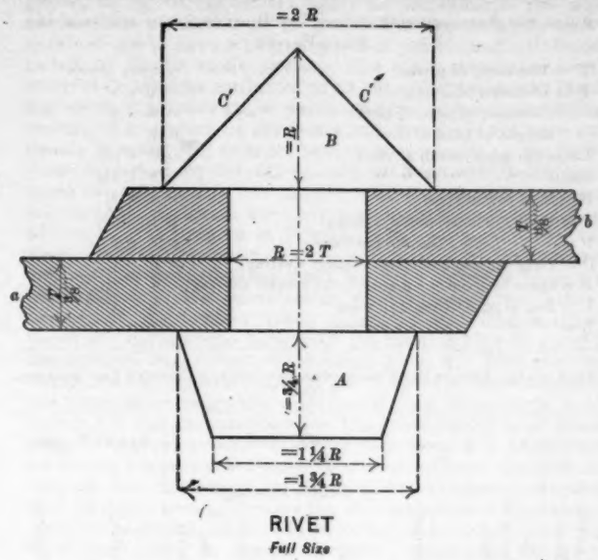


Fig. 153.

round enlargement, *A*, fig. 153, on one end, which is called the *tail* of the rivet. When used the rivets are heated red hot and are placed in the holes in the plates, and a second enlargement, *B*, fig. 153, called the *head* of the rivet, is formed on the other end, either by hammering by hand or by pressure between the two dies of a machine.

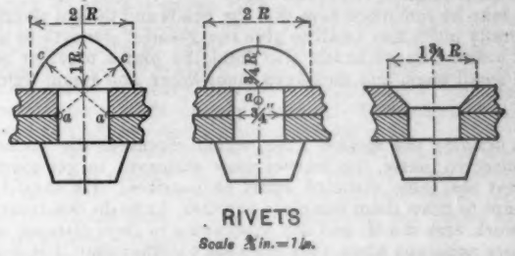
Experimental and theoretical investigations have shown that to get the greatest strength in a riveted joint the diameter and the distance apart of the rivets must bear a certain relation to the thickness of the plates which are held together, and that the heads and the tails should have certain proportions to the diameter of the rivet.

Fig. 153 represents an outside view of the ordinary form of rivet drawn full size. The shaded areas on each side represent sections of a portion of the plates. This is a common way of drawing sectional views which pass through the centers of rivets, bolts, shafts, rods, etc., as will appear in future illustrations. The irregular lines at *a* and *b* indicate that only portions of the plates are shown, and they are supposed to be broken off at these points. This is also a usual method of representing a part only of any object in a drawing.

It has been found that to secure the greatest strength in a lap seam or joint, the diameter of the rivets should be equal to twice the thickness of the plates. In fig. 153 the thickness of the plates is indicated by *T* and is equal to ⅜ in. The diameter of the rivet is indicated by *R*, and is equal to 2 *T*, or ¾ in.

The tail *A* of a rivet is usually made of the form shown in the

Fig. 154. Fig. 155. Fig. 156.



engraving, which is called a *frustrum of a cone*. Its flat end facilitates holding the rivet in the holes, while the heads are being formed.

The head *B*, shown in fig. 153, is cone-shaped. This is a usual form of rivet heads which are made by hand. The thickness of the tail *A* is equal to ¾ the diameter, or, as written in the engraving, = ¾ *R*. The large diameter of the tail = 1¾ *R*, and the small diameter = 1¼ *R*. The diameter of the head *B* = 2 *R*, and its height or depth = *R*. This makes the angle of its sides *C C* 45° to a perpendicular or horizontal line.

The student should draw the rivet as shown in the engraving, and then from the rules given should design and draw rivets for plates ¼ and ½ in. thick.

In doing this, center lines should first be drawn as described

Fig. 157.

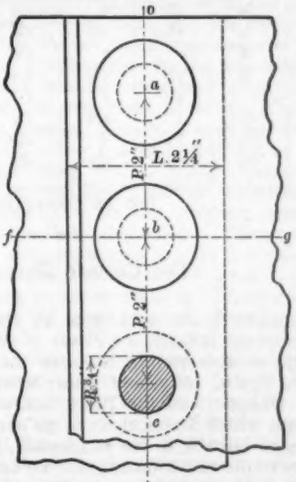
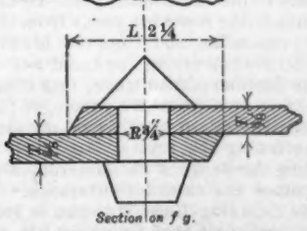


Fig. 158.



SINGLE RIVETED LAP BOILER SEAM

Fig. 159.

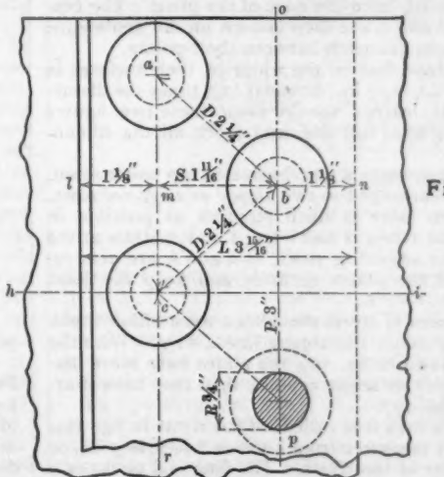
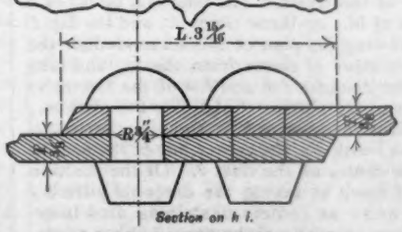


Fig. 160.



DOUBLE RIVETED LAP BOILER SEAM

Scale ½ in. = 1 in.

for drawing a bolt, and the thickness of the heads and the tails and their diameters should be laid off from these lines.

Various forms of rivet heads are used. Fig. 154 shows on a smaller scale what may be called a *Gothic head*, which cannot be readily made by hand, but requires a die to form it. It is somewhat stronger than a conical head. Its diameter and depth are the same as for a conical head. Centers *a a* should be found

on the edges of the plates which are in contact, from which, with a radius *a c*, *a c*, arcs may be drawn to form the outline of the head.

Fig. 155 represents a rivet with a *button-head*. Its diameter is also equal to twice that of the rivet, and its depth = $\frac{4}{7}$ *R*. Its outline may be drawn from a center on the center-line of the rivet with a radius which is easily found by trial after the diameter and height of the head is laid down.

In fig. 156 a countersunk head is shown. This form is only used when a projecting head would be in the way of some other object in contact with the plates, as a flange or bar. It is not as strong as the other forms of heads, and the countersink weakens the plate. Its diameter = $1\frac{4}{7}$ *R* and its sides have an angle of 45°, which determine its depth. The student should draw each of these rivets full size.

It may be remarked here that the heads and tails of rivets are generally made too small to give the greatest strength to a riveted seam. Large heads also hold the plates together better than small ones, and thus keep them water and steam-tight.

SECTION LINES.

In drawing the section lines, which represent the surface of the bisected plates, the learner must endeavor to get them all as near the same distance apart as possible. He should not attempt to draw them too close together, as to do this increases the work very much, and any inaccuracy in their distance apart is more apparent when they are near together than it is if they are further apart. If the scale of the drawing is larger than that of the engravings, the section lines should then be further apart than they are in the engravings. Practice and care will teach the young draftsman to draw these lines at uniform distances apart.

BOILER SEAMS.

Fig. 157 is a plan and fig. 158 a section of an ordinary single riveted lap boiler seam. The plates are of the same thickness and the rivets are the same size as are shown in fig. 153.

A center-line *o c* should first be drawn on which the row of rivets *a*, *b*, *c*, is laid out. The distance apart of the rivets, measured between their centers, or their *pitch*, as it is called (which is indicated by *P* in the engraving), is 2 in., or $2\frac{4}{7}$ times the diameter of the rivets. The first rivet, *a*, is laid off at a distance *o a* of half the pitch from the edge of the plate. The centers of other rivets, *b* and *c*, are then laid off on the center-line with dividers, by taking the pitch between their points.

The *lap* of the plates—that is, the width of their surfaces in contact (indicated by *L*), is $2\frac{2}{7}$ in., or equal to 3 times the diameter of the rivets. The learner should draw these two figures and the two following ones full size, and mark all the dimensions on them.

Figs. 159 and 160 represent a double-riveted lap boiler seam. The rivets of this are arranged in two *zigzag* or *staggered* rows. The object of this is to leave as much strength as possible in the plates between the rivets *a* and *c* and *b* and *p*, while at the same time those in the adjoining rows, as *a* and *b*, are near together, and thus hold the plates securely and keep the joint water or steam-tight.

With this arrangement of rivets the plates must either break on the line *a c r*, *o b p* or on the ziggag line *a b c p*. With the rivets arranged as shown in fig. 159, the plates have more material between the holes to resist rupture than they have if arranged as shown in fig. 157.

The *longitudinal pitch*, as it is called, of the rivets in fig. 159, or their distance apart measured from *a* to *c* or *b* to *p*, is 3 in., or four times the diameter of the rivets. The diagonal pitch, or *a b* (represented by *D*), is $2\frac{4}{7}$ in., or three times *R*, and the lap *L* $3\frac{13}{16}$ in., or $5\frac{4}{7}$ *R*. In drawing the plan of this seam, deduct the distance between the two rows of rivets from the lap and take half the remainder, as the distance *l m* and *b n* of the two rows of rivets, from the edges of the plates. Subdivide the pitch *a c*, and from the middle point *m* draw *m b* at right angles to *a c*. The point of intersection *b* with *o p*, the center-line of the second row of rivets, will be the center of the rivet *b*. Or the position of this rivet may be laid down by taking the diagonal pitch *a b* as a radius, and from *a* and *c* as centers describing arcs intersecting at *b*, which will be the center of the rivet. Other rivets, as *p*, may be laid off in the same way. In both figs. 157 and 159 sections through the body of the rivets *p* and *c* are shown, the heads being omitted. This is done to show the size of the body or shank more clearly.

Ordinarily, in a plan of a riveted joint the rivet heads are all omitted, the rivets being represented by circles when diameters are equal to those of the bodies of the rivets.

In cases as at *T T*, in figs. 158 and 160, when the space between the arrow-points is not sufficient to contain the dimensions, they are sometimes placed on the outside of the lines to which they refer, as shown in the figures referred to.

The following rules and table for the proportions of rivets and riveted seams will be found convenient in drawing them. With the exception of those relating to rivet-heads and tails, they have been taken from D. K. Clark's excellent *Manual of Rules and Tables for Mechanical Engineers*:

RULES FOR PROPORTIONING RIVETS AND RIVETED SEAMS FOR IRON AND STEEL PLATES.

T = Thickness of plates	= unity or one
R = Diameter of rivets	= T × 2
Diameter of head of rivet	= R × 2
Height of head of rivet	= R
Large diameter of tail of rivet	= R × 1¾
Small " " " " "	= R × 1¼
Height of tail of rivet	= R × ⅝
P = Pitch of rivets (single riveting)	= R × 2⅝
P = " " " (double riveting)	= R × 4
D = Diagonal pitch of rivets (double riveting)	= R × 3
S = Space between two rows of rivets (double riveting)	= R × 2¼
L = Lap of plates (single riveting)	= R × 3
L = " " " (double riveting)	= R × 5¼

TABLE GIVING PROPORTIONS OF SINGLE AND DOUBLE RIVETED LAP RIVETED SEAMS.

T Thickness of Plate.	R Diameter of Rivets.	Pitch of Rivets.				Lap of Plates.	
		P Single Riveting.	Double Riveting.			L Single Riveting.	L Double Riveting.
			P Longitudinal.	D Diagonal.	S Spacing between two Rows of Rivets		
Inch.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
⅛	¼	⅝	1	¾	$\frac{9}{16}$	¾	1$\frac{5}{16}$
$\frac{3}{16}$	⅜	1	1½	1⅛	$\frac{27}{32}$	1⅛	2
¼	½	1⅜	2	1½	1⅛	1½	2⅝
$\frac{5}{16}$	⅝	1⅝	2½	1⅞	1$\frac{13}{32}$	1⅞	3¼
⅜	¾	2	3	2¼	1$\frac{11}{16}$	2¼	3$\frac{15}{16}$
$\frac{7}{16}$	⅞	2⅜	3½	2⅝	2	2⅝	4⅝
½	1	2⅝	4	3	2¼	3	5¼
$\frac{9}{16}$	1⅛	3	4½	3⅜	2½	3⅜	5⅞
⅝	1¼	3⅜	5	3¾	2$\frac{13}{16}$	3¾	6½
$\frac{11}{16}$	1⅜	3⅝	5½	4⅛	3$\frac{1}{16}$	4⅛	7¼

(TO BE CONTINUED.)

The Corinth Ship Canal.

THIS canal is the subject of an elaborate paper in a recent number of the *Annales des Ponts et Chaussées*.

All the vessels trading between the Mediterranean ports of France, Spain, Italy, and Austria with Greece, Turkey, the Lower Danube, and the Black Sea, are obliged to round Cape Matapan, which forces them to go out of the course about two degrees of latitude to the southward, and, of course, the same distance to the northward again. By cutting through the Isthmus of Corinth, the route for goods from the Adriatic will be reduced by 185 sea-miles, and from the Mediterranean by 95 sea-miles. The toll for traversing the canal will be only 9.6 cents per ton for the Mediterranean trade, 19.2 cents per ton for the Adriatic trade, and 19.2 cents per passenger; and these tolls have been estimated to attain hardly half the amount which will be saved by shortening the routes. Moreover, the increase in safety, by avoiding the dangers encountered in rounding Cape Matapan, will reduce the rates for insurance. The total tonnage of the vessels rounding Cape Matapan is reckoned at 12,000,000 tons a year, and the Canal Company has estimated at less than half this amount—namely, at about 5,900,000 tons—the traffic which they may rely upon to pass through the canal. The passage of the canal will not be impeded either by the wind or by currents, for it is sheltered on both sides by hills, and the greatest possible difference of water-level in the gulfs at each end would be only 1 ft. 8 in. under exceptional conditions. The canal is being excavated in a straight line, in open cutting, having a length of 3 miles 1,656 yards, and it follows exactly the line of the Emperor Nero's project.

It will reach deep water at both ends about 660 to 990 ft. from the shore. The bottom width of the canal, of 72 ft., and

the depth of 26½ ft., are the same as on the Suez Canal ; but the proposed slopes of 1 in 10 through the rocky portion of the cutting will afford a width at the surface of the water of only 77½ ft., and a cross-section of 2,032 sq. ft., instead of the width of 177 ft., and the cross-section of 3,272 sq. ft. on the Suez Canal. The small section of the canal will be disadvantageous for navigation, owing to the limited space for the reflux of the water displaced by a vessel in its progress. The approach channels at each end are to have a bottom width of 328 ft., and will be protected by rubble stone jetties. The total excavation in the original design was estimated at 12,865,000 cubic yards, including about 2,400,000 cubic yards for slips or eventual enlargements. The nature of the strata had, however, not been sufficiently investigated, reliance having been placed on the indications furnished by the pits opened by Nero, which did not go down the full depth of the cutting, and from which it was conjectured that the strata were compact enough to stand at slopes of 1 in 10. The region is volcanic, and earthquakes are common ; and, consequently, it was not surprising that when the cuttings had reached some depth, a large number of faults were encountered, and a considerable disturbance of the layers of deposit of the tertiary strata was revealed. The maximum depth of cutting to the bottom of the canal is 284⅔ ft. ; and the mean depth, for a length of 2.6 miles, is 190 ft. With this mean depth, the cutting with slopes of 1 to 1 would involve three times the excavation originally anticipated ; but fortunately 1 to 1 slopes will not be necessary for the greater portion of the cutting, so that the amount of actual excavation will probably not exceed 1½ times the estimated quantity. Three methods were devised for excavating the channel : 1. Priestman excavators and dredgers were to remove the alluvial portions adjoining the gulfs on each side, amounting together to 3,270,000 cubic yards in the first year. 2. Special dredgers, constructed for the purpose, were to remove the excavation of the rocky portion, after the rock had been broken up by blasting, to the level of 167⅓ ft. above the bottom of the canal. This excavation, amounting to 7,063,000 cubic yards, was to be effected by the two special dredgers in three years. 3. The cap of the rocky mass above the aforesaid level, comprising 2,616,000 cubic yards, was to be removed by means of dynamite, excavators, and railways. The deep vertical blasting holes did not furnish the expected results, and therefore the special dredgers could not fulfill their object ; and the only operations which succeeded were the ordinary dredgings at the entrances to the canal, and the excavation of the rocky cap, carried out in the usual way and removed by wagons. The first period of the works, during which the above system of excavation was adopted, extended from the commencement in April, 1882, to the close of 1884. The rubble jetties and dredgings for forming harbors at each end were carried out during this period. The harbor in the Gulf of Corinth is protected by two converging jetties, 1,310 ft. and 1,640 ft. long respectively, with an entrance between their extremities 262 ft. in width ; and one jetty on the northern side affords adequate protection in the Gulf of Athens. The excavations effected to the end of 1884 amounted to only 1,700,000 cubic yards ; and the rate of progress afforded no hope of completing the work in 1888 according to the terms of the concession. The works entered upon a second stage when M. Bazaine was appointed Engineer-in-Chief ; and he extended largely the employment of wagons and locomotives for the removal of the excavations, and made flatter slopes in places to avoid the slips which were threatened owing to the number of faults. The excavation accomplished in the three years, 1885–87, reached 6,278,000 cubic yards. At the same time, as the cutting was carried down, the nature of the strata became more manifest ; and borings to the bottom of the cuttings, together with a geological survey of the whole route, enabled a definite opinion to be formed of the works required. In December, 1889, M. Bazaine reported that the principal indispensable works were : the protection of the sides of the canal with masonry in hydraulic lime or cement mortar for a height of 33 ft., along a length of from 2¼ to 2⅔ miles, to preserve them from erosion ; the formation of a bench, not less than 5 ft. wide, on each side of the canal, 6½ ft. above sea-level, to enable the walling to be carried out ; and the easing of the slopes at certain parts of the cutting to ensure their stability. He estimated that this scheme would involve 2,355,000 cubic yards additional excavation, and an increase of $2 000,000 in the cost ; and he proposed an extension of the time to the end of 1891, and various supplementary works.

A commission of experts has prolonged the extension of time for the works to the end of 1892, and the General Assembly of Greece has granted $3,000,000 for the additional cost and the supplementary works. The total cost of this canal will be about $12,000,000, or about $3,190,000 per mile, the excavation averaging 3,509,000 cubic yards per mile ; the cost will thus be about 91 cents per cubic yard excavated.

Recent Patents.

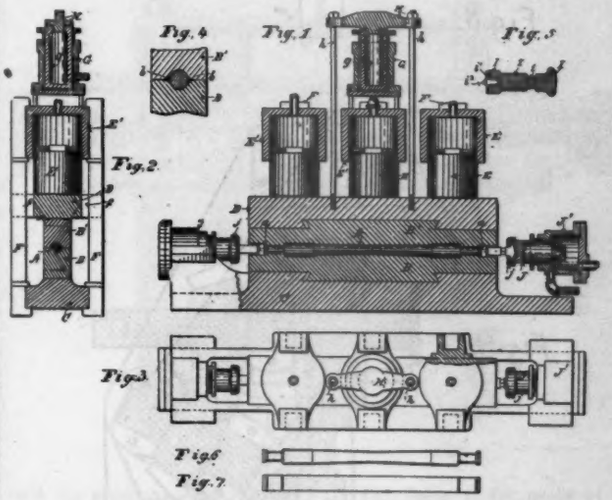
WELLMAN'S APPARATUS FOR FORGING CAR AXLES.

THE accompanying illustrations show apparatus for forging car axles, which is covered by Patent No. 422,357, issued to Samuel T. Wellman, of Cleveland, O. Fig. 1 is a side elevation partly in section ; fig. 2, a transverse section through the center of the machine ; fig. 3, a plan ; fig. 4, a cross-section of the dies on a larger scale ; fig. 5, the upsetting die ; figs. 6 and 7, elevation and plan of blank.

The machine is intended for rounding forged blanks previously prepared. These blanks have two parallel sides, as shown in fig. 7, and are of such variable width as shown in fig. 6, as will distribute the metal lengthwise the same as in the finished forging *A*, which is shown between the forging dies *B B'*. The lower die, *B*, is stationary, being secured to the bed-plate *C* ; the upper die is secured to the head *D*, to which are attached the plungers *E* of the water cylinders *E'*. These three cylinders are supported by heavy side pieces or columns *F*, one member, *f*, serving as a guide for the head *D*. The cylinders are connected so that they operate simultaneously.

Above the central cylinder and supported from the same is a smaller water cylinder *G*, having the plunger *g* connected with the cross-head *H*. The latter in turn is connected by means of rods *h* with the head *D*, and by operating this upper ram the die, head and plungers are elevated.

The dies *B B'* are adapted to fit the finished forging except



WELLMAN'S APPARATUS FOR FORGING AXLES.

that the internal corners at *b* are cut away, as shown more clearly in fig. 4. The recesses thus formed receive the metal that is forced laterally in breaking down the blank with the first closing of the dies, and prevents the forming of fins, which would stop the dies from closing. Outside the end collar *a* of the axles the bore of the dies is cylindrical to the end.

By operating the dies *B B'*, the axle is not drawn except at or near the ends, but at the ends the tendency to elongate is such that without other appliances the collars *A* would not be forged full and sharp, and the ends would be uneven and ragged. To avoid this upsetting dies *I* are provided, the heads *I'* being adapted to fit internally the end section of the dies *B B'*. The enlarged rounded ends I^2 of these upsetting dies enter corresponding sockets in the end of the plungers *J* of the double-acting rams *J'*. These are mounted on the ends of the bed-plate *C*. The dies *I* are held to fit their seats in the plunger by removable caps *j*, which fit so loosely that when the dies *B B'* are open the free ends of the upsetting dies may be raised a short distance. The length of the dies *I* is such that with the plungers *J* thrust forward their full throw the axle is upset to just the length required. For axles of different lengths or diameters the dies are changed. The collars *a* of the axles may be made longer without changing the large dies by substituting shorter upsetting dies and using a blank with more metal in the end.

In operating the apparatus, the blank is placed edgewise between the dies *B B'* and the dies are closed. At the same time the upsetting dies *I* are brought forward their full stroke and held in such position. The first stroke of the large dies *B'* breaks down the blank and fairly shapes the upper and lower section, but leaves ridges along the sides of the axles where the edges of the dies are cut away, as explained above. Next, the

metal, by means of the dies *I*—which have the sections *i* squared to receive a wrench for turning—is given a quarter turn to bring these ridges to the top and bottom. A few more strokes of the dies *B'*, the axle meantime being rotated between the strokes, finish the work, the entire operation requiring only a very short time.

MACHINE FOR ROLLING CAR-WHEELS.

Figs. 8, 9, 10, 11 and 12 show a method and apparatus for making metallic car-wheels, which is covered by patent No. 430,750, issued recently to Samuel H. Ralston and John R. Jones. Their invention consists in producing a car-wheel having a web and rim of uniform section and texture, and securing in the tread of the wheel a condensed and fibrous metal of great durability and tensile strength. This, the inventors claim, is accomplished by compressing the metal of the ingot from the center toward the periphery, and by rolling down the face or tread by means of movable rolls.

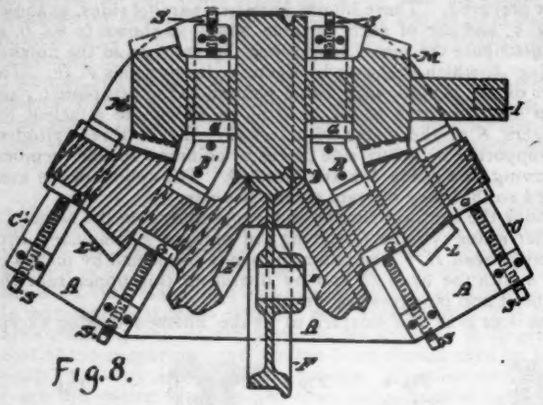


Fig. 8.

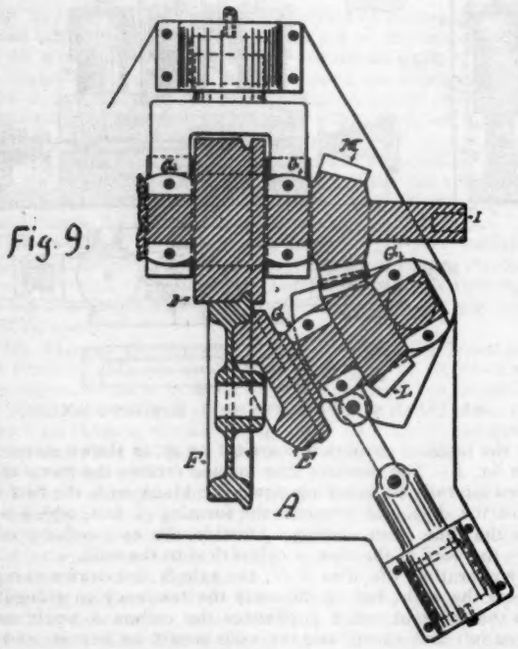


Fig. 9.

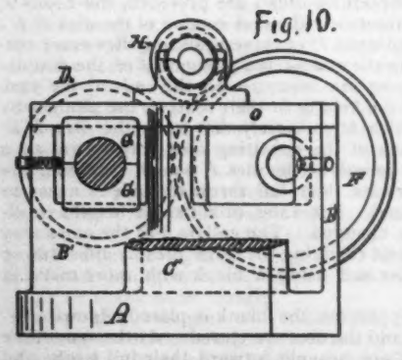


Fig. 10.

Fig. 11.

Fig. 12.

In the accompanying drawings, fig. 8 is a sectional plan of the machine with a finished wheel in place between the rolls; fig. 9 is a vertical plan showing the position of the rolls; fig. 10 is a side elevation showing the bed-plate and rolls; fig. 11 shows a section of the casting of the wheel ingot before rolling, and fig. 12 shows the movable friction and steadying roll.

In these illustrations *A* is the bed-plate; *B* and *C* are the main and side housings; *D* is the tread-roll, which is made movable by means of the screws *S* or by hydraulic pressure, and has grooves on its face of the requisite form to give size and shape to the tread or flange of the wheel and also to compress and extend it to any desired diameter. *E* and *E'* are two rolls upon movable bearings, having heads of such a shape as will compress the metal of the ingot outward from the center toward the rim, and produce the desired form of the web of the wheel which is being rolled. When the requisite thickness of web is secured, these rolls continue to revolve, carrying the wheel around with them and acting as clamps supporting the metal and holding it in place until the wheel is finished by the action of the tread-roll *D*. These rolls *E* and *E'* may be given a movement in right lines, as shown in fig. 8, or may be hinged, as shown in fig. 9. *F* in fig. 8 is a view of the finished wheel between the rolls; *G G* are the roll boxes; *H* is a friction roll, adjustable so as not to interfere with the increase in the diameter of the wheel, its object being to rest upon and clasp the tread and flange and also to prevent vertical movement and consequent distortion of the wheel during the process of rolling; *I* is the shaft through which power is applied; *M* and *M'* are pinions on the shaft *I*, by which power is transmitted to the side-rolls *E* and *E'* through the gear wheels *Q* and *Q'*, so that the revolution of the tread-roll *D* upon the shaft *I* causes a corresponding operation in the side-rolls.

To operate the machine the side-rolls *E* and *E'* are drawn or swung back, thus receding from each other, being guided by the flanges of the roll-boxes *G G*, fig. 8, or by the trunnions *N N*, fig. 9, moving upon the housings *B* and *C*. These housings diverge from each other, and the withdrawing of the side rolls *E* and *E'* permits the ingot to be inserted between the rolls, which are in gear through the pinions *M* and *M'* and *Q* and *Q'*. The mill is then started, and the side-rolls *E* and *E'* are gradually forced or driven upon the web and inside of the rim of the wheel, and the tread-roll *D* is gradually forced or driven upon the rim, or tread and flange, of the wheel until the desired reduction and formation have been accomplished. These rolls operate as if that portion of the web and tread which is held firmly and revolves between them and on which they are driven were an endless bar. As this portion is reduced in thickness by the rolls as they approach one another toward a common center in the tread, it becomes elongated and is drawn outward and expanded from the hubs, thus increasing the diameter.

AIKEN'S APPARATUS FOR MAKING CAR-AXLES.

The accompanying illustrations show an improved apparatus for the manufacture of car-axles, which is covered by patent 426,653, recently issued to Henry Aiken of Pittsburgh. The method used consists, generally stated, in enclosing a suitably shaped blank or bar in dies having matrices formed therein, and then subjecting the blank to endwise or laterally applied pressure, thereby causing the metal to conform in shape to the matrices. In the accompanying drawings fig. 13 is a side elevation of the machine; fig. 14 a sectional plan on the line *x x*, fig. 13; fig. 15 is a sectional elevation on the line *y y*, figs. 13 and 14; fig. 16 is a sectional elevation on the line *z z*, fig. 15; figs. 17, 18 and 19 show the blanks and a finished axle, and fig. 20 is a transverse section of a modified arrangement of the apparatus.

The frame of the machine consists of a base, 1, cheek-pieces 2, supported by the base, and a cap, 3, resting upon the cheek-pieces, the said parts being firmly held together by the horizontal bolts 4, 5 and 6 and by the vertical bolts 7 and 8. The horizontal bolts 4 and 6 pass through the cap and base, respectively, as well as through the cheek-pieces; but the bolt 5 passes through the cheek-pieces only, and as said pieces serve as guides for the carrier-block 10 a section of pipe, 9, is placed around the bolt 5 and bears at its ends against the cheek-pieces, so as to prevent the latter from being sprung inwardly when the nuts on the ends of the bolts 5 are tightened up. The same function can be effected by forming shoulders on the bolt 5.

Between the cheek-pieces is arranged a heavy casting, forming the carrier 10, guided at its ends by the cheek-pieces, as before stated. This carrier is vertically slotted, as shown in fig. 15, so as to permit of the passage of the bolt 5 without interference with its vertical movements, which are effected by the piston 12 of the fluid-pressure cylinder 13, arranged, as

shown in figs. 13, 15 and 16 upon the base 1, and held in position laterally by a stud, 14, formed thereon and fitting in a socket in the base. The dies 15 and 16, having suitable matrices formed therein, are secured to the cap 3 and carrier 10, and in the adjacent faces of the dies, at the ends of the matrices, are cut grooves 17, which, when the dies are closed, form passages for the upsetting-plungers 18 These plungers are attached to

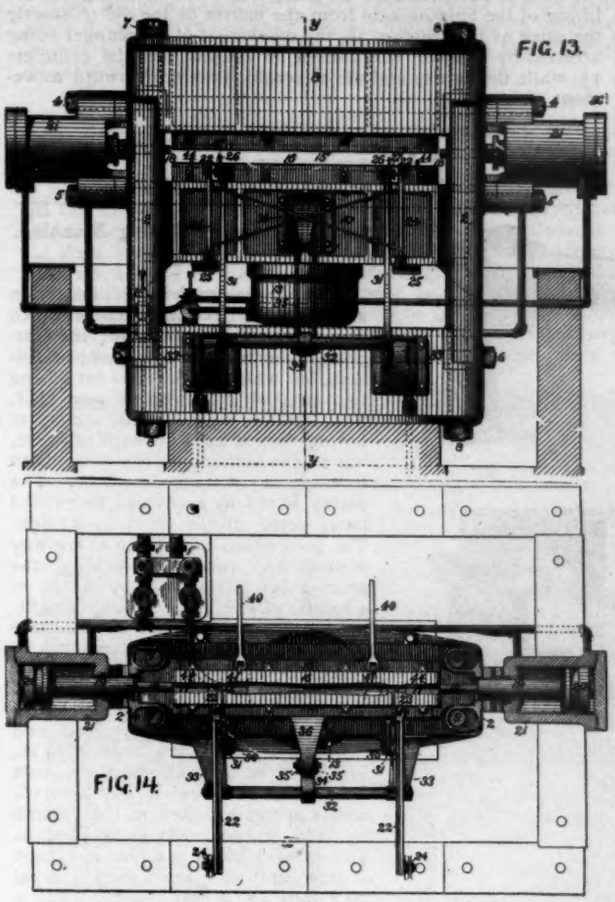


FIG. 13.

FIG. 14.

the stems 19 of the pistons 20 of the fluid-pressure cylinders 21, which are preferably secured to the cheek-pieces 2 by the bolts 4 and 5, as shown in fig. 16.

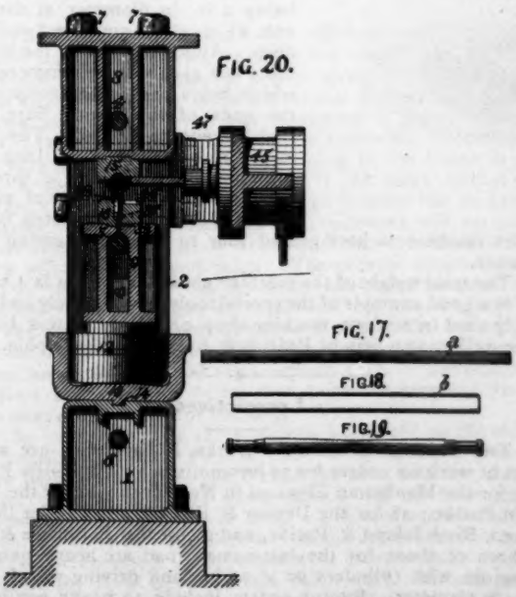


FIG. 20.

FIG. 17.

FIG. 18.

FIG. 19.

For convenience of operation, the machine is so arranged in a pit, as shown in figs. 13, 14 and 15, that the dies will be readily accessible from the floor-level, and when operating the blanks are placed upon rails 22, pivoted at their inner ends to ears 23 on one side of the lower movable die 16 and at their outer ends to posts 24, also pivoted to shoes 25, secured to the floor of the

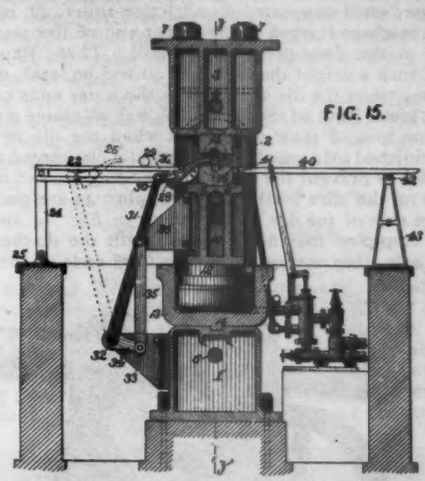


FIG. 15.

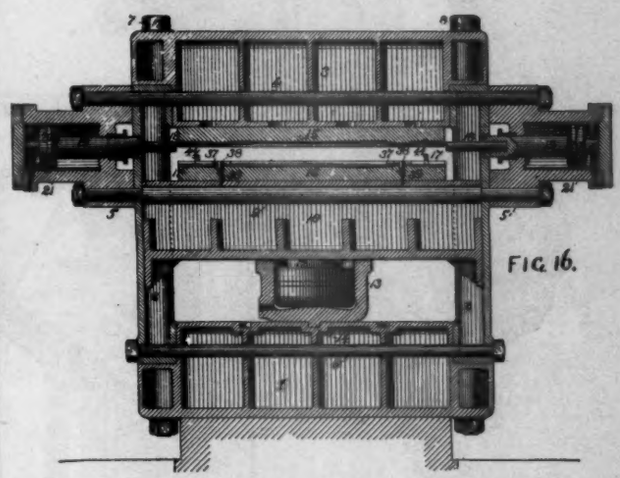


FIG. 16.

mill, as shown in figs. 14 and 15. The posts 24 are made of such a height that when the die 16 is raised the rails 22 will be level or approximately level, so that any blanks placed upon the rails may not roll off, but will either roll or slide down toward the die 16 when it is lowered, or will remain in position until forced toward and into the die by the dogs 26. These dogs are pivoted to blocks 27, mounted in dovetailed grooves in the inner walls of the rails 22, as shown in fig. 13, and have their outer ends weighted, so as to hold their inner ends normally above the rails and to permit said inner ends to be depressed and pass under a blank during the outward movement of the sliding blocks.

In order to prevent too great movement of the dogs, lugs 28 are formed on their outer ends, so as to engage pins 29 on the sliding blocks. These blocks 27 are connected by links 30 to the upper ends of the arms 31, which are attached to a rock-shaft 32, mounted in brackets 33, bolted to the base 1, as shown in figs. 13 and 15. A crank, 34, projecting from the shaft 32, is connected by a link, 35, to a bracket, 36, bolted to the carrier 10, so that when the carrier is raised the rock-shaft is so turned as to move the blocks and dogs outwardly, the latter passing under and behind the blank on the rails, and then the carrier is lowered, separating the dies, the dogs are moved inward, pushing a blank before them into the matrix of the lower die, thereby displacing a completed axle.

In the lower die are formed sockets 37 for the reception of the crutches 38, which fill the sockets and have a firm solid bearing in the bottoms thereof, and have their upper faces shaped to form a part of the matrix and register therewith during the blank-shaping operation. These crutches are provided with stems 39, extending down through the die and adapted to engage the bolt 5, or the pipe surrounding the same, when the carrier is lowered, thereby holding the crutches and the finished axle stationary while the die 16 continues its downward movement. The stems are so proportioned as to length that the axle

will be held clear of its matrix when the die has reached the lower limits of its movement, and can therefore be readily pushed from between the dies on to the receiving-rails 40 by the incoming blank. The receiving-rails 40 are pivoted at their inner ends to ears 41, formed on the side of the lower die 16, and have their outer ends supported on a friction-roller, 42, mounted in suitable bearings formed in the upper end of the standards 43, secured to the floor-plate of the mill. These standards are made of such a height that the rails 40 will be level, or approximately so, when the die 16, carrying the inner ends of the rails, is at the lower limit of its movement, but will have a downward inclination toward their outer ends when the die is raised, so that the finished axle may be automatically discharged therefrom.

In order to prevent the blanks from being pushed beyond the matrices of the dies by the dogs 26, pins 44 are placed on the discharge side of the die 16, as shown in figs. 14 and 15, and that the stop-pins may not interfere with the discharge of the finished axle, they are located beyond the ends of the matrices, so as to engage the ends of the blank, which is longer than the axle to be formed while permitting the finished axle to pass between them.

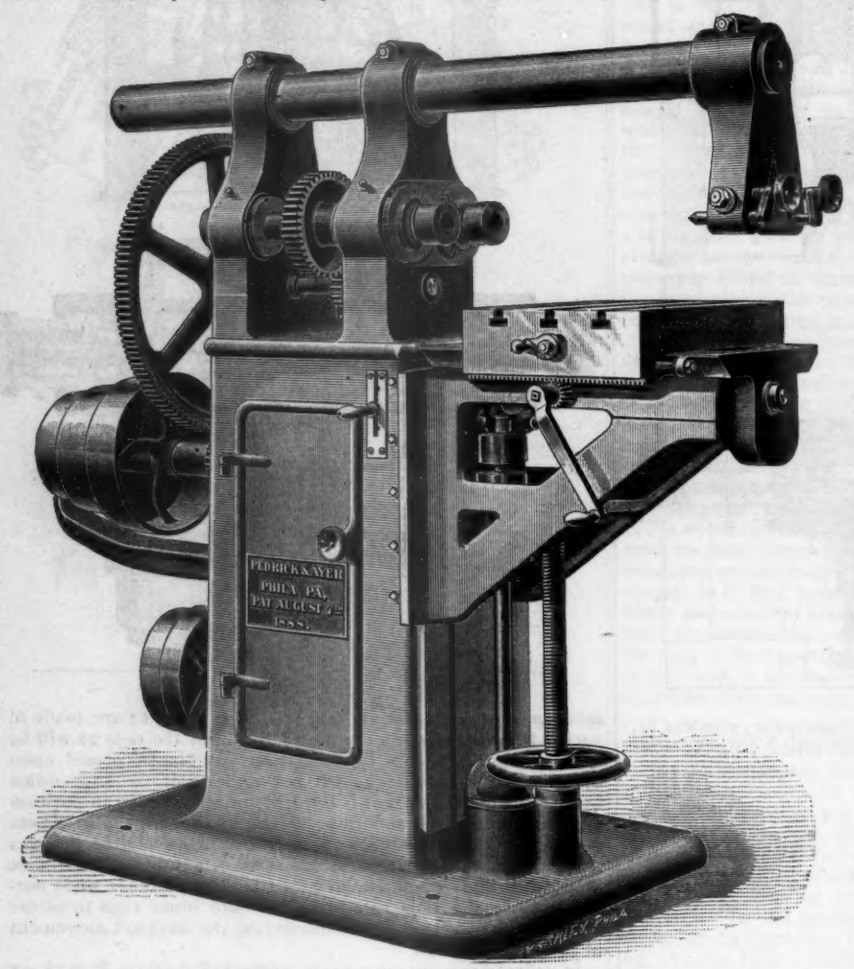
In fig. 20 is shown a form of apparatus wherein the slot through which the plunger 46 operates is formed by recesses cut in the adjacent or meeting faces of the dies 15 and 16, the plunger 46 and its operating-cylinder 45 being supported in a horizontal position by brackets 47, secured to the cap or top piece of the machine. In this construction of machine there will not be any rotation of the blank as the lower die is raised, and said die has sufficient movement to afford space when the die is at the lower limit of its movement to permit of the insertion of the blank or the removal of the finished axle under the plunger 46. As the plunger does not in this arrangement afford means for the removal of the axle, the crutches or strippers 38 are employed.

It will be observed that the blank is entirely inclosed in the die-matrix and slot leading therefrom before any flow of the metal occurs, and also that the operative face of the plunger 46 is so constructed that its edges are merged into the walls of the die-matrix, and that therefore there will not be any liability of forming a fin or other projection on the axle. The meeting faces of the dies being held in close contact, no metal can be forced between them, and the plunger fitting snugly in the slot in the die 16, and the edges of its operative faces being made like a knife and merging its walls into the wall of the matrix, no projection or excrescence can be formed on the axle.

It will be observed that the plunger 46 operates as regards the lifting of the finished axle from the matrix of the die 16 exactly the same as the crutches 38, the movement of the plunger being arrested by its lower end coming in contact with the cylinders 13, while the carrier and die 16 continue their downward movement.

Manufactures.

A New Duplex Boring Machine.



DUPLEX BORING MACHINE.

THE accompanying illustration shows a duplex boring machine which was designed and built for the purpose of boring out two pump cylinders, but which can be used for boring two parallel cylinders of any kind. The distance between the centers of boring bars is fixed for each machine, but in the building of the tool it can be made any distance required. The platen is fed by a nut and screw, the latter being driven by a 2½-in. belt. The power-feed can be run either way without any change in belting, the gearing being reversed by means of a handle shown near the upper right-hand corner of the door in the base of the machine. The feed-nut can be turned in or out of contact with the screw by one turn of a small crank. The hand-feed of the platen has a quick return for counter-boring, and the total travel of the table is 14 in. The knee or bracket which supports the platen can be raised and lowered, and is securely bolted to the column by bolts whose heads fit in T-slots. The spindles of the machine are made of steel, and each has a main journal $3\frac{1}{4} \times 6$ in. and a rear journal $2\frac{9}{16} \times 5$ in. A hole $1\frac{1}{16}$ in. in diameter runs through each spindle, and the ends are bored taper to receive cutter bars or other tools, the hole for the same being 2 in. in diameter at the large end, 1½ in. at the small end and 12 in. deep. Along the top of the machine there is a 4½-in. bar of hammered steel which holds the center supports for the ends of the boring bars, when such support is needed. The platen is 16 in. wide and 20 in. long. The machine is driven by a three-step cone, the largest diameter of which is 14 in.; the face of each step is 4½ in. The machine is back-geared four to one, thus giving ample power.

The total weight of the machine shown in the cut is 4,500 lbs. It is a good example of the special tools so extensively and profitably used in modern machine-shop practice. It was built by the well-known firm of Pedrick & Ayer, of Philadelphia.

Locomotives.

THE Baldwin Locomotive Works, Philadelphia, are at present at work on orders for 32 locomotives for the Union Pacific; 30 for the Manhattan Elevated in New York; 27 for the Northern Pacific; 48 for the Denver & Rio Grande; 12 for the Chicago, Rock Island & Pacific, and 20 for the Baltimore & Ohio. Three of those for the last-named road are heavy passenger engines with cylinders 20 × 24 in., and driving-wheels 6 ft. 6 in. in diameter. Recent orders include 10 heavy engines for the Mexican Central; 12 for the Mexican Interoceanic and 12 for the Mexican Pacific. Three compound locomotives are

nearly completed for a railroad in Brazil, and one compound consolidation freight for the Mexican National. Other foreign orders include eight engines for Japan and three for the railroad from Jaffa to Jerusalem.

THE Pittsburgh Locomotive Works have recently built seven locomotives for the Louisville, New Albany & Chicago Railroad.

THE Baldwin Locomotive Works are building for the Baltimore & Ohio three passenger engines with 20 × 24-in. cylinders and 78-in. drivers; also seven heavy ten-wheel engines with 21 × 24-in. cylinders.

The New Model Lake Steamer.

THE accompanying illustration—for which we are indebted to the Cleveland *Marine Review*—shows the steamer *Colgate Hoyt*, the first steamboat built by the American Barge Company, of West Superior, Wis., after the model for whale-shaped freight carriers devised by Captain Alexander McDougal. A number of these barges have already been built, and the intention is to have the steamboat tow a train of five or six of the loaded barges, bringing transportation expenses down to the lowest possible point. The Company has established large yards at West Superior for the construction of these vessels, which are, as the illustration shows, really *whale-shaped*, and which, the inventor claims, present the largest space for cargo combined with a form adapted to resist storms and other obstacles to navigation, and to present the least resistance to propulsion.

STEAMER "COLGATE HOYT."

The steamer is necessarily arranged somewhat differently from the barges, the principal changes being in the house arrangements above the deck. The hull is the same as that of the barges excepting in the run aft, which is more like an ordinary steamer. The vessel shown in the illustration will carry about 2,600 net tons on 15 ft. of water, and with this draft the cabin deck will be 15 ft. above water. The general dimensions are: 280 ft. long over all, 30 ft. beam and 22 ft. moulded depth. She has Hodge fore-and-aft compound engines, with cylinders 26 and 50 in. in diameter by 42 in stroke. The boilers, built by the Lake Erie Boiler Works, at Buffalo, N. Y., are 11½ ft. long, and carry 150 lbs to the square inch. The quarters for officers and crew are better than might be expected from the peculiar arrangement of the ship.

The cabin rests on three turrets, supported on the sides by 12 ventilation pipes. Four of these ventilate the engine-room, four perform the same duty for the fire-hold, and four the cargo hold. The captain and other officers will all have spacious quarters in the cabin above deck, which also contains a dining-room 20 × 11 ft. The different rooms are finished in oak and elegantly furnished. The wheelmen, firemen and other members of the crew have quarters below deck, forward and aft, and the engine-room is large and well lighted. In the turret forward is one of the American Ship Windlass Company's steam windlasses, with the capstan above. The *Hoyt* has hand-steering gear, with the shaft and hub of the steering wheel of brass to avoid affecting the compass. On the port side of the cabin forward, just aft of the pilot-house, there is also a chart room and office combined.

It is further claimed for these vessels that they can be built for 25 per cent. less than a wooden steamer of the same carrying capacity. This is a very important consideration, especially where the traffic is carried on under so sharp a competition as on the lakes.

On her first voyage down the *Colgate Hoyt* carried a cargo of 2,800 tons of iron ore, her draft with this great load being only 15 ft. The average speed on this trip, from Ashland to the Sault Ste. Marie, was 13 miles an hour.

Manufacturing Notes.

THE shops of William Sellers & Company, Philadelphia, are now building for the Baldwin Locomotive Works' new shops, two 100-ton high-speed traveling cranes, each with two 50-ton trolleys, for a span of about 75 ft., and for a shop about 340 ft. long. Each crane is to be driven by electric motors on the hanging platform, and is to have the following speed per minute: 100 ft. and 200 ft. on runway, 50 ft. and 100 ft. on bridge, and 5, 10, 20 and 40 ft. hoisting and lowering, all variable without shock or jar from zero to maximum, at the will of the operator.

THE Pond Engineering Company, of St. Louis, has recently opened branch offices in Dallas, Tex., and Seattle, Wash., to assist in handling its increasing business in the Southwest and on the Pacific Coast.

Cars.

THE Central Railroad of Georgia has recently placed an order with the Ohio Falls Car Company, Jeffersonville, Ind., for 32 passenger and two sleeping cars; also for 100 coal and 50 stock cars.

THE North Carolina Car Company, Raleigh, N. C., is building a number of freight cars for the Seaboard & Roanoke Railroad.

THE United States Rolling Stock Company's Shops in Anniston, Ala., are building cars for the East Tennessee, Virginia & Georgia; the Georgia Southern & Florida, and the Savannah, Americus & Montgomery Roads.

NEW car shops of considerable size are being built at Basic City, Va.

THE Baltimore & Ohio Railroad Company has let contracts to the Pullman shops, Pullman, Ill., for 1,000 gondola cars 34 ft. long; to the Wells & French Company, Chicago, for 250

flat cars; also for 500 box cars, to be 34 ft. long, 50,000 lbs. capacity, to have journals 4½ × 8 in., and to be fitted with Westinghouse air-brakes and automatic couplers.

THE Edgar Thomson Steel Works, Braddock, Pa., are to be enlarged by the addition of three 15-ton converters.

THE Standard Metal Tie & Construction Company, New York, has just finished laying 1,500 of its ties on the Delaware & Hudson Canal Company's line near Ballston, N. Y.

THE Ross-Meehan Brake-Shoe Foundry Company is about to build a foundry and a malleable iron plant at Chattanooga, Tenn.

NOTICE is given by the Lappin Brake Shoe Company, of New York, that the recent enlargement of its works has given increased facilities and lessened the cost of manufacture, and the price of both plain and flanged shoes has therefore been reduced to 4 cents per lb.

Bridges.

THE Pottsville Bridge Company has recently been organized to carry on a bridge building business in connection with the works of the Pottsville Iron & Steel Company, at Pottsville, Pa. The main office will be in Philadelphia. The officers are: President, William Atkins; Vice-President and Engineer, H. L. Forte; Treasurer, John M. Callen.

THE San Francisco Bridge Company, San Francisco, Cal., has the contract for building railroad bridges on the Northern Pacific Road over the Snohomish, Skagit and Stillaquamish rivers in Washington.

THE contract for a steel bridge over the Savannah River near Savannah, Ga., has been let to Mr. Grant Wilkins of Atlanta, Ga., who takes the entire contract, both for the foundations, masonry and superstructure. The bridge will have two fixed spans of 125 ft. each, and one draw span of 250 ft.

THE Detroit Bridge & Iron Company is building an iron draw-span on the Fairhaven & Southern Railroad.

THE Youngstown Bridge Company, Youngstown, O., has the contract for a bridge over Klingle Creek near Washington. The same company is building several highway bridges in West Virginia.

THE Edge Moor Bridge Company, Edge Moor, Del., has the contract for a bridge over Rock Creek near Washington.

THE channel span of the Ohio River Connecting Bridge, near Pittsburgh, was successfully placed August 19. This span, which is entirely of steel, is 523 ft. long, and the trusses are 73 ft. in depth; it was erected on barges and floated into place when the water was at the proper stage. When it was in place the barges were sunk gradually, leaving the span resting on the piers. The placing required very careful work, and was completed without accident.

Marine Engineering.

IN the yard of the Detroit Dry Dock Company at Wyandotte, Mich., there was recently launched the steel propeller *Maryland*, which is intended to carry iron ore from Escanaba to Chicago. The *Maryland* is 335 ft. over all; 316 ft. on the keel; 42 ft. beam, and 24 ft. depth of hold. She is expected to carry 3,500 tons on a draft of 16 ft. She has a double bottom, and can carry 1,200 tons of water ballast. The engines are triple-expansion, with cylinders 22, 35 and 56 in. in diameter and 44 in. stroke. Steam is furnished by two steel boilers, each 14 ft. 2 in. in diameter and 11 ft. 6 in. long, built to carry 160 lbs. working pressure.

TWO steel steamers intended for coasting trade are nearly ready to launch from the Wheeler Yards at Bay City, Mich. These vessels are 300 ft. long, 41 ft. beam, and are intended to carry 3,500 tons on 22 ft. draft. The engines are of the triple-expansion, surface-condensing type, with cylinders 21, 35 and 56 in. in diameter and 42 in. stroke. The building of coasting steamers at a Lake yard is something new.

THE new steam ferry-boat *G. R. Sherman*, built for the ferry across Lake Champlain between Port Henry, N. Y., and Chimney Point, Vt., is 99 ft. long. It is a side-wheel boat, the paddles being driven by a compound condensing engine with cylinders 10 in. and 17¾ in. in diameter and 12 in. stroke. There are two boilers, each 4 ft. 8 in. in diameter and 8 ft. long, carrying a working pressure of 125 lbs. The engine and boilers were built by the Erie Iron Works, Erie, Pa. The ferry is 2¼ miles long, and the usual speed is 8 miles an hour.

THE steamship *Essex*, for the Merchants' & Miners' Transportation Company, of Boston, was recently launched from the Cramp Yards in Philadelphia. The *Essex* is 260 ft. long, 40 ft. beam and 35 ft. 6 in. depth of hold. She has a triple-expansion engine with cylinders 24, 39 and 59 in. by 48 in. stroke. The working pressure is 155 lbs. The ship is expected to make from 14 to 15 knots an hour.

OBITUARY.

SAMUEL A. BLACK, who died at his home in Bryn Mawr, Pa., August 2, aged 70 years, was for many years connected with the Pennsylvania Railroad, having served in different positions, and from 1858 to 1874 as Division Superintendent. He was afterward for some years Superintendent of the Northern Pacific, but retired from railroad work some 10 years ago.

M. K. BELKNAP, who died suddenly in Louisville, Ky., July 19, was a civil engineer, and studied his profession in France. He served on the Louisville & Nashville some 10 years, and in 1879 was appointed Engineer and Superintendent of the Mexican Central. A year later he returned to the United States, and in 1885 was made Superintendent of the Vicksburg & Meridian and the Vicksburg, Shreveport & Pacific Railroad. In 1887 he was appointed General Superintendent of the Central Railroad of Georgia, and later General Manager. He resigned that office last year to accept the Presidency of a banking company in the City of Mexico.

JOHN BRANDT, who died in Portland, Ore., recently, aged 65 years, was born in Lancaster, Pa., and began work on the Erie Railroad, where he served as engineer and afterward as Master Mechanic in charge of the Susquehanna shops. He was afterward for a time connected with the old New Jersey Locomotive & Machine Works, in Paterson, and was Superintendent of the Cincinnati & Chicago Air Line Railroad. In 1872 he was appointed Master Mechanic of the Oregon & California Railroad. For some years he had been Superintendent of the Southern Pacific Lines in Oregon.

HENRY J. DAVISON died on board the steamship *Majestic*, at Liverpool, July 22, aged 55 years. He was born in New York, and at an early age entered the old Chelsea Iron Works, and after learning the trade became a contractor on his own account. He obtained considerable reputation by undertaking the removal of the remains of the Crystal Palace after the building had been destroyed by fire, which was considered a very difficult undertaking. He established himself finally as a mechanical and consulting engineer in New York, and was employed in many important works. He built gas works in a number of cities, and was very successful in introducing the manufacture of water gas. He constructed the telegraph lines in the United States of Colombia, and was instrumental in introducing light draft steamers on the Magdalena River in that country. He was also one of the projectors of the elevated railroad system in Brooklyn, and was largely instrumental in securing its construction. Mr. Davison was a member of several public bodies, and was well-known for his public spirit and interest in the general welfare. At the time of his death he had just taken passage on the *Majestic* on his return from a trip in Europe.

PERSONALS.

W. A. CATTELL, heretofore Assistant Superintendent of Roadway of the Long Island Railroad, is now Assistant Chief Engineer of that road.

C. B. COUCH has resigned his office as Superintendent of the Eastern Division of the Lake Shore & Michigan Southern, on account of ill health.

A. L. GARDNER is Manager of the Baltimore & Washington Car Service Association, which includes all the railroad lines entering or passing through Baltimore.

I. GROVE has been appointed General Manager of the Colorado Coal & Iron Company, with office at Pueblo, Col. He was recently in charge of iron works at Youngstown, O.

P. D. FORD, heretofore Superintendent of Roadway of the

Long Island Railroad, is now Chief Engineer of the road, in charge of bridges and tracks, as well as of all surveys and construction.

E. M. HERR has been appointed Master Mechanic of the Chicago, Milwaukee & St. Paul Railroad at Milwaukee, Wis. He was recently Division Superintendent on the Chicago, Burlington & Quincy.

H. H. FILLEY, Consulting Engineer of the Mexican National Construction Company, who has been residing in Kansas City for some time past, has returned to Mexico. His residence will be in the City of Mexico.

JOHN ORTTON has been appointed Superintendent of Motive Power of the Toledo, St. Louis & Kansas City Railroad. Mr. Ortton has had an extensive experience both in England and in this country, where he has served on the Great Western, the New York Central & Hudson River and other prominent lines.

RICHARD COUGHLIN, of Paterson, N. J., who is now 80 years of age, claims the honor of being the oldest railroad conductor in the United States, as he had charge of a train on the old Paterson & Hudson River Railroad—now part of the Erie—in 1833. Mr. Coughlin is still well and strong, though he has retired from active business.

R. C. CARPENTER, for 15 years past Professor of Engineering in the Michigan Agricultural College, has been appointed Professor of Experimental Mechanics at Cornell University, and has removed to Ithaca, N. Y. Professor Carpenter has been an active member of the Michigan Engineering Society, was for several years its Secretary and is now the President.

PROCEEDINGS OF SOCIETIES.

Engineers' Society of Western Pennsylvania.—At the regular meeting in Pittsburgh, June 17, resolutions were adopted urging upon the Government the erection of a movable dam in place of the fixed dam and lock which it is proposed to put up at Herr's Island in the Allegheny River, for the reason that a fixed dam will, during ordinary floods, raise the surface of the water several feet, causing much loss and damage to manufacturing interests, and also preventing the free passage of ice.

Mr. Phineas Barnes made an address on Sundry Rolling Mill Appliances, illustrating his remarks upon a blackboard.

Master Car Builders' Association.—Secretary John W. Cloud has issued a circular, accompanied by very full illustrations, submitting to members of the Association for their decision by letter-ballot the several standards proposed at the recent Convention. The questions are as follows:

1. On the adoption as a standard of the journal box, bearings with wedge, and the malleable lid for cars of 60,000 lbs. capacity, as shown by the drawings.
2. On the adoption as a standard of the same form and size of malleable lid for the standard journal-box for cars of 40,000 lbs. capacity. The drawings for this journal-box are so made that a pressed steel lid may be used instead of the malleable lid.
3. The adoption as a standard of the plans presented at the Convention for loading logs and poles upon cars, the method being shown in the drawings accompanying the circular.
4. On the adoption as a standard for the plans for racking cars for loading bark, this plan being also shown in the drawings.
5. On the adoption as the standard height for draw-bars on passenger equipment cars of 35 in. from top of rail to center of draw-bar, when the car is light.
6. On the adoption as a standard for safety chains for passenger equipment cars, a chain with all links made of ⅞-in. iron and 1¼ in. wide inside; to be arranged as proposed at the Convention and shown on the drawings.
7. On the adoption as a standard of 40° as the lateral angle which the brake beam lever makes with the vertical.
8. On the adoption as a standard of a fitting on the ends of train-pipe for steam heating, consisting of a 2-in. female pipe fitted with standard pipe-thread.

Civil Engineers' Club of Cleveland.—At the regular meeting, Cleveland, O., August 12, a committee of three was appointed to co-operate with the committee of the Western Society of Engineers in forming a plan for holding an International Congress of engineers in Chicago in connection with the World's Fair in that city.

A paper by Mr. James Ritchie on some Recent Constructions in Railroad Bridges was read.

The Author began by noting the increased activity in the construction of iron railroad bridges in the Southern States, showing that the desire for more permanent and substantial work was taking more hold of the managers of the Southern roads. The largest recent bridge of note is that across the Ohio River, at Ceredo, W. Va., consisting of one channel span of 518 ft., two side spans 298 ft. each, and a series of approach spans, the total weighing upward of 3,250 tons. A large number of other bridges are in process of construction, including many plate girders, and fixed and draw spans up to 212 ft. In the Southwest, considerable iron bridge construction is going on, and in the Northwest there is an increasing number of these iron bridges; also in the Northeast many bridges are building. The Maine Central is replacing its wooden bridges by iron ones, while the New York Central is building several bridges of steel. Particular mention is made of a plate girder span of the New York Central, 115 ft. in length and 9 ft. deep, in which the web plates are placed with the fiber vertical. The new swing bridge on the Lake Shore Road, across the Cuyahoga River, is described as a double-track through bridge 306 ft. long, with steel eye-bars, and the balance of iron. The total weight of the superstructure is 328 tons; the turn-table 133 tons. In commenting upon specifications of bridges, he regards those by Mr. George S. Morrison, for the Memphis Bridge, as the most complete and systematic, and on account of the minuteness of their details, they are not susceptible of being evaded. Nothing impossible to comply with should be written in specifications, and all reasonable conditions should be rigidly enforced. The use of steel in bridges, seems to be increasing, and many roads allow Bessemer or open-hearth to be used, while the New York Central allows the use of open-hearth only. In testing full-sized iron eye-bars to destruction, the writer has noticed that failure takes place near one head or the other, indication that the material might have been injured in manufacturing, and recommends annealing the same, as is done with steel bars. This might not produce the desired result, but a few experiments in this manner might be of great benefit.

The reading of this paper was followed by a general discussion which covered the use of iron and steel in bridge construction, the different kinds of steel, the length of plate girders and lattice bridges, and the relative merits of pin-connected and riveted bridges.

Iron and Steel Institute.—The provisional list of the papers to be read at the meeting of the British Iron & Steel Institute in this country, in October, has been issued by the Secretary. It will be seen that all the papers announced are by Americans.

1. American Blast Furnace Yields; James Gayley, Pittsburgh.
2. Testing Materials of Construction in the United States; Messrs. Hunt & Clapp, Pittsburgh.
3. The Manufacture of Steel in the United States; Henry M. Howe, Boston.
4. The Thomson Electric Welding Process; Professor Thomson, New York.
5. The Manufacture of Spirally Welded Steel Pipes in the United States; J. C. Bayles, New York.
6. The Development of the Iron Manufacture of Virginia; E. C. Pechin, Cleveland, O.
7. The Use of Water Gas in the United States; B. Loomis, Hartford, Conn.
8. The Coke Industry of the United States; J. D. Weeks, Pittsburgh.
9. Recent Progress in the Manufacture of War Material in the United States; W. H. Jaques, Bethlehem, Pa.
10. Composition and Wearing Qualities of Steel Rails; Dr. Charles B. Dudley, Altoona, Pa.

Two papers by members of the Institute will be read at the International Meeting in Pittsburgh as follows:

1. Protection of Iron and Steel Ships against Foundering from Injury to their Shells; Sir N. Barnaby, London.
2. Recent Development of Marine Engineering; A. E. Seaton Hull, England.

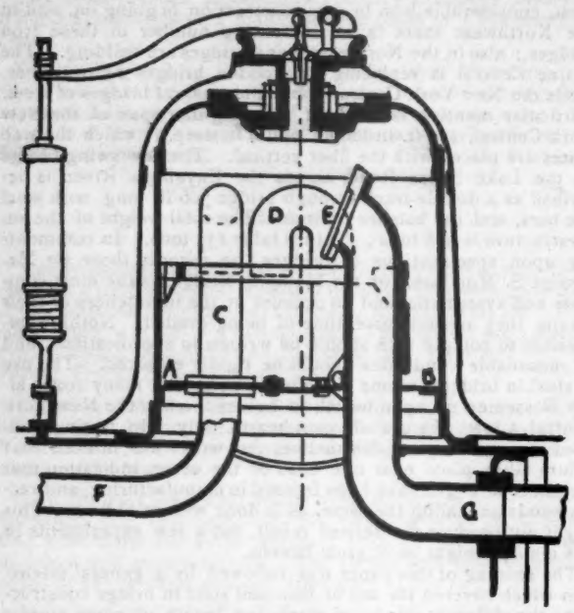
Sir Lowthian Bell has also promised to prepare a paper setting forth his views on the present state of the iron manufacture.

NOTES AND NEWS.

Ice Making in New York.—The scarcity of stored ice naturally resulting from a very hot summer following a mild winter has stimulated the artificial manufacture of ice, and it is to be tried on a large scale in New York. The New York Steam Company has nearly completed three factories for that purpose. The first one occupies a building 25 × 100 ft. in size and five stories high, which will have a daily capacity of 60 tons of ice, besides cooling two floors of the building which are used

for storage. The other two factories are each 100 × 100 ft. in size, with a capacity for making 120 tons of ice daily. In all these the ammonia compression system is used, and the Company has very little doubt that they will prove a financial success.

A Locomotive Steam Dome.—The accompanying sketch shows an arrangement adopted on the Paris, Lyons & Mediterranean Railroad for locomotive boilers, the object being to secure dry steam. The upper part of the dome is separated from



the boiler by the diaphragm *A B*; steam is admitted by two curved pipes *C* and *D*, the lower end of *D* opening directly into the boiler, while *C* is connected with the dry pipe *F*, which runs back to the rear end of the boiler. The throttle valve, of the gridiron pattern, is at *E*, steam passing into the steam-pipe *G* as shown.

Steam entering the dome through the pipes *C* and *D* is, by their curved form, thrown down against the diaphragm *A B*, where any particles of water which may be carried over will be deposited. It is stated that this arrangement works very well in practice, giving dry steam almost invariably, under all conditions of working.

International Electrical Exhibition.—An International Electrical Exhibition is going to take place in Frankfurt-am-Main, in Germany, in 1891, at which electrical apparatus of all descriptions will be shown. Special attention will be paid to exhibits and statements of the progress made in electric lighting and the use of electricity in supplying power in cities.

In connection with this Exhibition, it is intended to hold a congress of electrical engineers, to which delegates from all countries will be invited. In connection with this an invitation is to be extended to the members of the International Gas Congress, which meets at Munich, to attend, in order that, in Germany at least, matters may be so arranged as to avoid unnecessary rivalry between the electric lighting and gas interests in the cities.

Improvement of the Navigation of the Danube.—After long negotiation, arrangements have been finally completed, and a plan has been agreed upon for the impovement of the navigation of the Lower Danube, a matter of great importance to the countries and cities of Eastern Europe. The works required are of three kinds:.

1. The deepening of the river channel through the rocky bars which at present obstruct it.

2. The construction of dams to secure uniform depth of water at all seasons.

3. The excavation of the navigable canal around the famous Iron Gates.

The work of the first class includes the blasting out of the reefs in the bed of the river at Stenka, at Kozla, at Doghe, at Izlas, at Jucz and at Greben. The depth of the excavation varies at these points, but at all of them it is proposed to make a channel not less than 2 m. (6.56 ft.) in depth at mean low water, and 60 m. (197 ft.) in width. These works will require a total amount of excavation of about 210,000 cub. yds., a considerable portion of which will be rock.

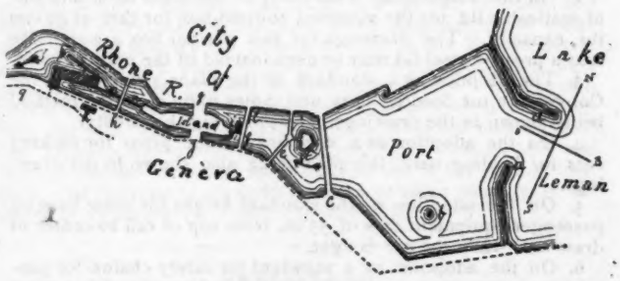
The second part of the work will require the construction of two dams. The first will be situated at the reef known as the Greben Spit, at the foot of the Greben Rapids, the object being to establish a level of water over the rapids. The dam here will be a large one, nearly 20,000 ft. in length and 10 ft. wide at the summit, the sides having an inclination of 1 to 1½. It will be a rock-filled dam and will be about 7 ft. in height above the present average level of the river. The second dam will be situated near the town of Jucz and will be somewhat shorter, being 12,600 ft. in length. The boats will pass these dams by means of locks.

At the famous Iron Gates, which have so long been a barrier to the navigation of the river, a canal will be built, the engineers considering that this will be the most direct and cheapest method of overcoming the obstruction. This canal will follow the right bank of the stream; will be 260 ft. wide at the surface and 7 ft. in depth; will be 6,955 ft. in length, and to a considerable distance will be close to the river and separated from it only by a dike. This canal will require the excavation of about 330,000 cub. yds. of rock.

It is estimated that all the works can be completed by the close of 1895, and that their total cost will be $5,000,000.

River Improvements at Geneva.—An interesting work has lately been completed at Geneva in Switzerland, the objects of which were two: To utilize the power developed by the Rhone on its exit from Lake Leman or Geneva, and to regulate also the level of the lake as far as possible. Some works formerly constructed by the city of Geneva had so far obstructed the course of the river as to raise the level of the lake at the time of the melting of the mountain snows and cause an overflow of its banks, which had resulted in a dispute between the cantons of Geneva and Vaud, which has been settled by the new arrangement.

The works included the clearing out and deepening of the river bed; the construction of a power-house containing a number of turbines, and the dividing of the channel into two parts, one of which remains unobstructed at all seasons, while the other, by means of an island and a dike extending from the island to the power-house, is directed to the latter, where its waters are employed to drive the turbine wheels. Gates are provided in the dike by means of which in time of flood the amount of water passing down the river can be increased and the level of the lake kept even, within comparatively narrow limits. The power developed by the turbine wheels is used to pump water from the river to a reservoir situated upon a hill at a considerable height above the city, and from this reservoir the water supply of the town is drawn. It is also used for another purpose, for the power was found to be sufficient to pump out more water than was required for ordinary domestic purposes, and in addition it is now supplied to a number of manufacturing establishments of different capacities, where it is used to furnish power. Arrangements are also being made for building a second reservoir, from which water can be supplied at higher pressure, furnishing a greater amount of power, and in time it is thought that most of the factories in the city will be run in this way. At present 10 turbine wheels are in use in the power-house, and this number can be doubled without exhausting the supply of water from the river which can be utilized.



At the close of the last year these city works furnished a total amount of 1,440 H. P. to 201 different motors, including those employed in the Central Electric Lighting Station, and in 80 different factories. When the high-pressure system is completed this force will be largely increased.

The accompanying engraving gives a general idea of the arrangement of the works. It is a sketch map showing their position, in which *a a* is the entrance into the port of Geneva from the lake; *c*, *e*, *f*, *g* and *h* are bridges over the river; *i* is the old power-house and dam, now removed; *o* is the new power-house, and *m n* the dike below the island above referred to, in which gates can be opened when necessary to carry off the water.

Electric Case-Hardening.—Professor Elihu Thomson has recently devised a method of case-hardening iron or steel by means of the heat produced by the passage of an electric current. His process consists essentially in heating the object electrically, and then applying to the metal so heated a surrounding envelope (either gaseous, fluid or solid), for the purpose of changing or preventing change in the quality of the material, according to the special end to be attained.

The method is applicable not only to those cases where it is desirable to prevent oxidation or change of character in the surface of the metal object which is heated in the welding, forging, or shaping operation, but is also applicable to producing an addition to, or modification in, the character of the surfaces of the metal object, either independently of, or simultaneously with, the forging, shaping or other working operation performed upon the metal. Thus, for instance, it can be applied to the local hardening of parts of steel bars and the local case hardening of iron or mild steel bars when heated by the passage of the current for the purpose of welding, forging, shaping, etc.

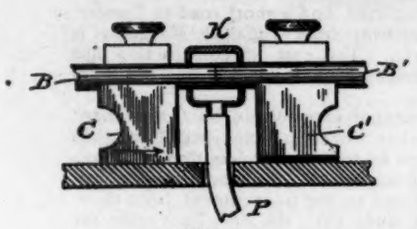


Fig. 1.

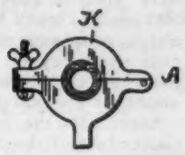


Fig. 2.

To prevent oxidation Professor Thomson surrounds the iron and steel bars with a hydrocarbon gas or other gas containing no oxygen, such as hydrogen or nitrogen. To chill and harden steel the heated bars are suddenly surrounded with cooling fluid, such as water or oil. To case-harden the bar it is surrounded with a layer of case-hardening flux—such as cyanide of potassium, yellow prussiate of potash, shavings of horn, animal charcoal, leather cuttings, and carbonate of potash, or the like—and the pieces kept hot by the current until the required case-hardening is effected as a result of the addition of carbon to the surface layer of the material.

The accompanying illustration, fig. 1, shows the apparatus designed to accomplish this. As shown, the bar to be treated is surrounded by a casing, *K*. This casing is supplied, through a pipe, *P*, with ordinary coal-gas or gasoline vapor during the heating of the metal, so as to preserve the same from oxidation during the welding or like operation performed upon the object heated.

The casing is constructed of sheet-iron, and made in two parts, hinged at *A*, as shown in fig. 2. Evidently it must not make electrical contact with the object treated, but must be guarded therefrom by mica, asbestos or other insulating and refractory material applied at the points where the object enters the casing.

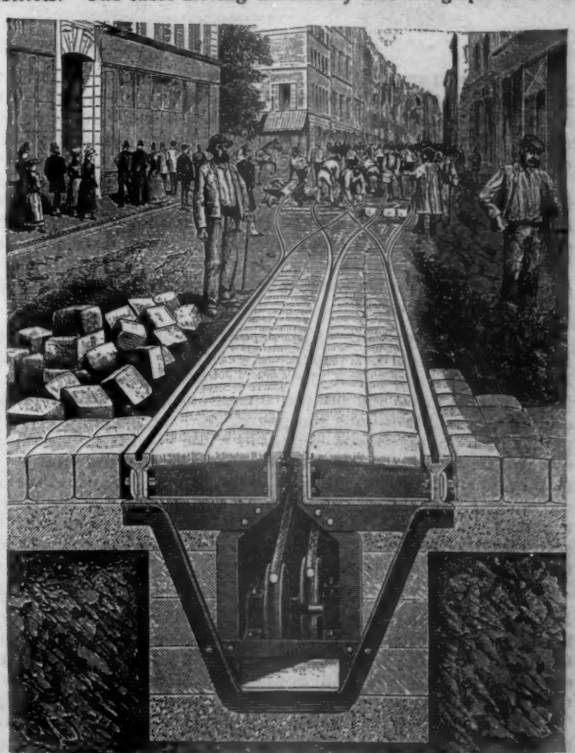
Oxidizable metals are by this means thoroughly protected at their surface, and, in fact, with gases rich in carbon, will receive when highly heated a veritable protective layer of deposited carbon, which gradually carbonizes the surface of an iron bar while heated and steelifies or case-hardens it.—*Electrical Engineer.*

A Long Electric Railroad.—The longest electric railroad yet proposed is a line from St. Petersburg, Russia, northeast to Archangel on the White Sea, a distance of 500 miles. It is proposed to furnish power from a series of generating stations placed at convenient points along the line, and the total cost, including equipment, is estimated at only about $15,000 per mile.

Archangel, which is a port having a considerable commerce at certain seasons of the year, lies in 64½° north latitude, close to the Arctic Circle, and it is claimed by the advocates of the lines that the electric road will overcome the difficulty which might be experienced in running steam locomotives in winter in that extreme northern latitude.

Petroleum in India.—In a lecture recently delivered before the London Society of Chemical Industry, Mr. Boverton Redwood stated that in India petroleum occurs in Upper and Lower Burma (including the Arakan Islands), in Assam, in the Punjab, and in Beloochistan, and described in detail the various deposits, as well as the steps which have been taken to render them commercially available. In Arakan the most productive fields were believed to be those of Ramri and the eastern Baranga Island, in both of which localities petroleum of a very high quality, in some cases sufficiently pure to be capable of being burned in ordinary lamps in its crude state, was obtained. The well-known oil fields of Upper Burma situated near Yenangyoung, the product of which has long been an article of commerce, were next described. In his account of the Punjab oil deposits attention was directed to the importance of the results, especially from the point of view of providing liquid fuel for use on the railways, which had attended the drilling operations at Khatan, in Beloochistan. The lecture was illustrated by a large number of typical samples of crude petroleum from the various districts enumerated, and full particulars were given of the physical and chemical characteristics of these samples. In India, as in Russia and Galicia, owing to the disturbed character of the strata in which petroleum is found, drilling is attended with difficulties. The most abundant supplies of oil were those obtained from the wells at Khatan, any one of the five wells already drilled being capable of furnishing the entire supply of 50,000 barrels of oil a year, which is estimated to be the amount required for the Sind-Pishin section of the Northwestern Railway. From the point of view of the kerosene manufacturer the Arakan oil was the best, but, on the other hand, much of the Yenangyoung oil yielded a large percentage of paraffin, which was a valuable product; and the yield of kerosene from the latter oil was capable of being largely increased by the adoption of a process recently devised by Professor Dewar and the lecturer. Too little was at present known about the oil fields of India to admit of a confident prediction as to their future. But it was pointed out that unless the necessary operations were carried out under skilful, energetic, and experienced management, disappointment and discouragement would probably ensue, and the development of the oil fields of India would be retarded. The action of the Indian Government in proposing to sell the oil-producing territories in sections, instead of granting prospecting licenses, was commended as being likely to afford some guarantee for efficient development. In the discussion which followed the lecture, Mr. Charles Marvin gave a number of interesting particulars in reference to the immense importance of the liquid fuel question, in relation to the action which Russia had been enabled to take in supplying her railroads with petroleum refuse from Baku.

Cable Railroad in Paris.—Paris is soon to have its first cable railroad, which will connect the Belleville and Montmartre districts. The cable-driving machinery and the grips used will

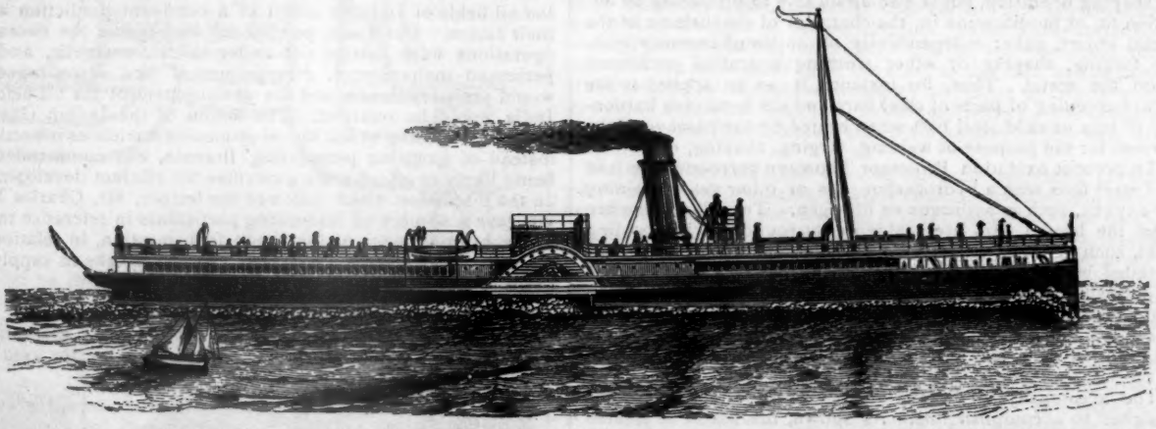


be copied from American patterns. The cable is to run at a speed of 10 kilometers (6.214 miles) an hour. Should this line prove successful, the system will be extended to others. The line is a single track, with turn-outs for cars to pass. The accompanying engraving, from *Le Genie Civil*, shows the arrangement of the cable conduit, rails, etc., as adopted for the road.

Slate Production.—The first bulletin issued by the Census Office for the census of 1890 concerns the production of slate in the United States, and has been prepared by Dr. David T. Day, of the Geological Survey. Slate is produced in 12 States and Territories, nine of which are on the Atlantic Coast. There is one quarry in Arkansas; one in Utah and two in California, but the production of these is very small. The principal slate regions are in Vermont and Pennsylvania, these two sections together producing more than three-fourths of the entire output. In all there are 206 quarries, and the total value of the slate produced last year was $3,444,863. In another year Tennessee will probably be added to the number of slate-producing States.

An English Passenger Steamboat.—The accompanying illustration, from the London *Engineer*, shows the passenger steamboat *Duchess of Hamilton*, recently built by Denny Brothers, of Dumbarton, Scotland, for the Caledonian Steam Packet Company. The steamer is 250 ft. long, 30 ft. beam, and draws 5 ft. 6 in. of water in ordinary working trim. She has a single stokehold with three boilers and seven furnaces; the engines are of the compound diagonal type, designed by Mr. Walter Brock, one of the partners of the firm.

The *Duchess of Hamilton* has extensive cabins below, and a promenade deck above, running the whole length of the ship. The passenger accommodations are unusually good for an English steamboat.



The contract speed was 17 knots an hour, but on the trial trip a speed of 18.1 knots was reached, the builders securing by this a premium of $15,000 over the contract price. In service she makes a run of 13½ miles in 38 to 40 minutes; being at the rate of 21.3 to 20.25 miles per hour.

The steamboat is employed on the line from Ardrossan across the Firth of Clyde to Brodick on the Island of Arran, running in connection with the trains of the Caledonian Railway. This service is very similar to that on Long Island Sound, near New York, and it is interesting to note the difference in type and general appearance between this boat and those used for like traffic in this country.

A Novel Pavement.—At a recent meeting of the Inventor's Institute, in London, a paper was read on road making by Mr. D. Nicoll. He proposed the use of blocks of granite 5 in. by 3 in., wrapped, except on the upper surface, with waste fiber and an elastic bituminous compound, and the whole brought together in a homogeneous condition while resting on a continuous pad formed of the same substance. This continuous pad or slab is taken to the ground and unrolled over the usual surface of concrete; the blocks are then placed diagonally and forced together. It is said that a horseshoe finds a ready hold for stopping or starting a vehicle, and that the noise is much less than with the ordinary slippery granite.

Railroads in Java.—The system of railroads in Netherlands India dates from the year 1862, when a concession was given by the Governor-General to the Netherlands India Railroad Company to build a road from Samarang to the independent states of Djokjokarta and Sourakarta, with a branch line to Cembarawa or Fort Willem I., which was completed in 1873. Two years previously, in 1871, the Government began preparations for constructing a line westward from Djokjokarta through Karang, Anjar, and Maos to Tjilatjap, which was not, however, opened for traffic until 1887; and from Djokjokarta eastward to Pasarouan via Sourabaya, with branches to Blitar, Malang, and Probolingo, which are also now in operation. On the Government lines the cost of construction has been, on an average, about 69,294 florins per kilometer, or $44,850 per mile.

On the west of the island concessions were given, in 1865, to the same company for making a road from Batavia to Buitenzorg, and in 1871, the Government took measures for the continuation of the railroad to Bandong in the Preanger residency. This has been completed, and, moreover, continued beyond to Garoet, with the intent to make a junction with the Djokjokarta line to Tjilatjap, the only port on the south coast of Java. It is understood that this railroad will be open for traffic within three years, though the prosecution of the work through the mountainous country in this part of the island necessitates much labor and expense in bridging, excavating, grading, and tunneling; Bandang and Garoet, for instance, lying at an altitude of over 3,000 ft. above the sea. A branch line from Batavia to Bekassi has lately been completed, and a short road to Tangerang is proposed, while a railway from Tagal to Margosari is also open beyond Banjaran. The cost of construction has therefore been, on an average, about 99,452 florins per kilometer, or $64,320 per mile.

Since 1875 the average annual expenditure on Government railroads and the new harbor works at Tandjong Priok has been between $2,800,000 and $3,200,000, not less than $32,000,000 having been paid during the decade following for this object alone. As regards the returns to the Government from these roads, it may be said that, until 1877, the only lines open for traffic were the private railroads between Batavia and Buitenzorg, of 30 miles, and the Samarang, Djokjokarta, and Cembarawa lines, of 126 miles. The company contracted to return to the Government the advances received during their construction, and to add thereto a share of the net profits. The amount thus paid increased gradually from $22,900 in 1871 to $408,000 in 1876, which sums have been paid over to the Government in Holland, through the corporation's agents there, while it has also declared an annual dividend of about 8 per cent. during the past 10 years for the benefit of its stockholders. The rolling stock on all of the lines is of small pattern, but built in durable though very simple style.

In Sumatra a line has been built by a private company to connect the several Delli tobacco plantations, and a branch is now being laid to Babougan. At Padang the Government has built a part of the line to Moera Kalabang for a distance of 34 miles to the base of the mountains, and is at present undertaking the most difficult portion, a three-railed track—such as is in use in Switzerland—being now necessary to reach the highlands. A thorough survey has been made of this region by a Government engineer, who has published a large work upon the mineral deposits in this region, in which he declares that there are extensive beds of coal of the best quality here, which lie near the surface of the land and may therefore be easily worked. It is expected, consequently, that the opening of this line will be attended by a great increase in the supply and by a cheapness of this article, which is now obtained at considerable expense from Australia, Japan, and England.

At the military station, at the northern point of Sumatra, there is an excellent steam tram-way in operation, similar to the lines in Sourabaya and Batavia. At the last-mentioned place the track is about seven miles in length, and extends through the principal streets of the city from the harbor to the suburbs, the tracks being double for the greater part of the distance. The locomotives are from the German works at Düsseldorf. They are provided with steam at the termini from stationary boilers. The steam enters the boilers at 200 lbs. pressure, and this supply proves sufficient for maintaining, with a train of four tram-cars, an average speed of 10 miles an hour, with stops at stations about half a kilometer apart. A dividend of 6 per cent. is declared annually. The net receipts for 1886–87, from all lines, were $1,938,400 and $1,788,200, respectively.—*Report of U. S. Vice-Consul Wood to the State Department.*